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COUPLING SYSTEM DESIGN OPTIMIZATION
A Survey and Assessment of Automatic Coupling Concepts for Rail Freight Cars
Volume II: Text and Appendices

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FINAL REPORT

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16. Abstract

The purpose of this study is to provide an independent identification, classification, and analysis of significant freight car coupling system concepts offering potential for improved safety and operating costs over the present system.

The basic method of approach was to make a comprehensive search as a prerequisite to establishing significant coupler concepts which would be used to formulate candidate coupling systems. The search program consisted of a literature search, a patent search, and railroad industry interviews.

Coupling development efforts have been decreasing due to changing usage and profitability of the American railroads. The functional concepts of existing development efforts range in sophistication from increasing the gathering range of the present coupler system to providing automatic train air connection and a complete redesign of the mechanical coupler.

A sufficient number of new coupler concepts were identified to derive coupling systems which represent a significant improvement over the present system. This is the second of two volumes. Volume I, 48 pages, is an executive summary.

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PREFACE

The work described in this report was carried out under the direction of the Transportation Systems Center of the U.S. Department of Transportation in the context of an overall project of the Federal Railroad Administration (FRA) to provide a technical basis for the improvement of rail transportation service, efficiency and productivity. The work was sponsored by the FRA Office of Research and Development, Office of Freight Systems.

The work reported here has been coordinated with the Association of American Railroads (AAR) Advanced Coupling Concepts Steering Committee. It is an element of a larger program initiated by the FRA and AAR Joint Study Group on Advanced Coupler Concepts which contains both economic and technical elements.

This final report is organized into two volumes. The Executive Summary (Volume I) is an easily readable summary of the project to survey and assess coupler systems for rail freight cars. The Report (Volume II) includes the full documentation and details of the project activity.

Kearney gratefully acknowledges the cooperation of the many railroads, rapid transit companies, manufacturers, research and development organizations, U.S. Patent Office, AAR Technical Center, AAR Advanced Concepts Steering Committee, and other interested parties who provided the information required to conduct a professional, objective study. We would also like to thank DOT personnel in the Transportation Systems Center and the Federal Railroad Administration for their cooperation and assistance throughout the course of the study.

Finally, the authors are grateful to L.K. Kloss for his help in preparing this report.

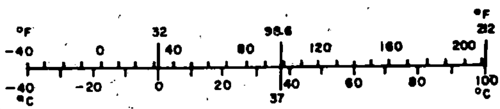
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

METRIC CONVERSION FACTORS

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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ABBREVIATIONS

AAR	-	Association of American Railroads
COMPENDEX	-	Engineering Index
DOT	-	U. S. Department of Transportation
EPA	-	U. S. Environmental Protection Agency
FRA	-	Federal Railroad Administration
ISMEC	-	Science and Mechanical Engineering Abstracts
NASA	-	National Aeronautics and Space Administration
NTIS	-	National Technical Information Service
ORE	-	Office for Research and Experiments
OSHA	-	Occupational Safety and Health Administration
RPI	-	Railway Progress Institute
RRIS	-	Railroad Research Information Service
R-TRIS	-	Regional Transportation Research Information Service
TRIS	-	Transportation Research Information System
TSC	-	Transportation Systems Center
UIC	-	International Union of Railways

1. INTRODUCTION

1.1 OBJECTIVE AND SCOPE

The purpose of this study is to provide identification, classification, and analysis of significant freight car coupling systems concepts offering potential for improved performance and operating costs over the present system. This study is being carried out in coordination with the Association of American Railroads (AAR) and the Railway Progress Institute (RPI) advanced coupling concepts program.

Research and development projects have been conducted by industry suppliers and others over recent years to design various coupler systems or coupler system components. The primary thrust of the R&D effort has been for U.S. rapid transit application or for European rail service. The functional concepts of these advanced systems range in sophistication from increasing the gathering range of the present coupler system to providing automatic train line air connection and a complete redesign of the mechanical coupler. Some of these systems are in the conceptual stage; others have advanced beyond physical prototypes to actual installation. To evaluate the potential of advanced coupling systems for enhancing operating efficiency and for providing greater safety in coupling operations, an organized review of the proposed and existing advanced coupling concepts was required. The review identifies those systems offering potential for major improvements in the current freight coupling operations.

1.1.1 Study Objectives

1) To assemble and synthesize information related to

advanced coupler systems in terms of their respective functional concepts.

2) To identify, characterize, and select the most promising concepts of these systems and group them into logical combinations for candidate coupling systems which warrant further study.

3) To conduct an objective feasibility study and preliminary engineering and cost analysis of the concepts in the candidate coupling system; specifically excluded is an estimate of the benefits of implementation.

1.1.2 Study Scope

The scope of the study includes advanced coupler concepts that have been proposed either domestically or abroad, patented or nonpatented, regardless of their respective stage of development or degree of sophistication.

The results of this project will be coordinated with the economic study of advanced coupler systems under AAR sponsorship. For this reason, particular emphasis was placed upon evaluation of advanced coupling systems from the functional standpoint as they might impact railroad operational procedures, safety and efficiency of operations.

The scope of the study does not includes original research, design of hardware, or development. The thrust of the study is to review and characterize work performed by others and to identify and evaluate concepts that could most readily effect improvements in the rail freight industry.

1.2 BACKGROUND

In the early days of American railroading, freight, and passenger cars were coupled together with links of chains. This coupler system had many drawbacks, and was replaced by a link and pin type coupler. The link and pin coupler was reasonably effective in holding cards together. However, to make up a train, it was necessary for the brakeman to stand between cars during coupling, guide the link into the socket, and then drop the pin that would hold the cars together. As a result, it was responsible for more deaths and injuries to railroad employees than any other single cause. (See Figure 1-1).

The need for an improved coupler system was apparent. In 1848, the filing of numerous coupler patents was begun by A. G. Heckrotte, although his device was not accepted. Twelve years later, D. A. Hopkins of Elmira, New York, patented a device that was tried for a short time by the Erie Railroad, but later abondoned as unsatisfactory. In 1863, Ezra Miller designed and built a coupler system called the "Miller Hook." This was hailed as the solution. Many roads experimented with it, but it, too, was rejected.

In 1868, a former Confederate officer, Major Eli Hamilton Janney, patented an automatic coupler. (See Figure 1-2). The Janney coupler is recognized as the direct ancestor of the present-day coupler. Coupling was accomplished by a movable knuckle which closed automatically upon car engagement. Uncoupling was accomplished by using a manually operated side lever. Coupler problems still prevailed, since repair and replacement of the Janney coupler was difficult, and miscoupling occurred frequently because of a limited gathering range. Gathering range is the amount of horizontal or vertical distance from the coupler center line within which the coupler will operate properly when coupling.

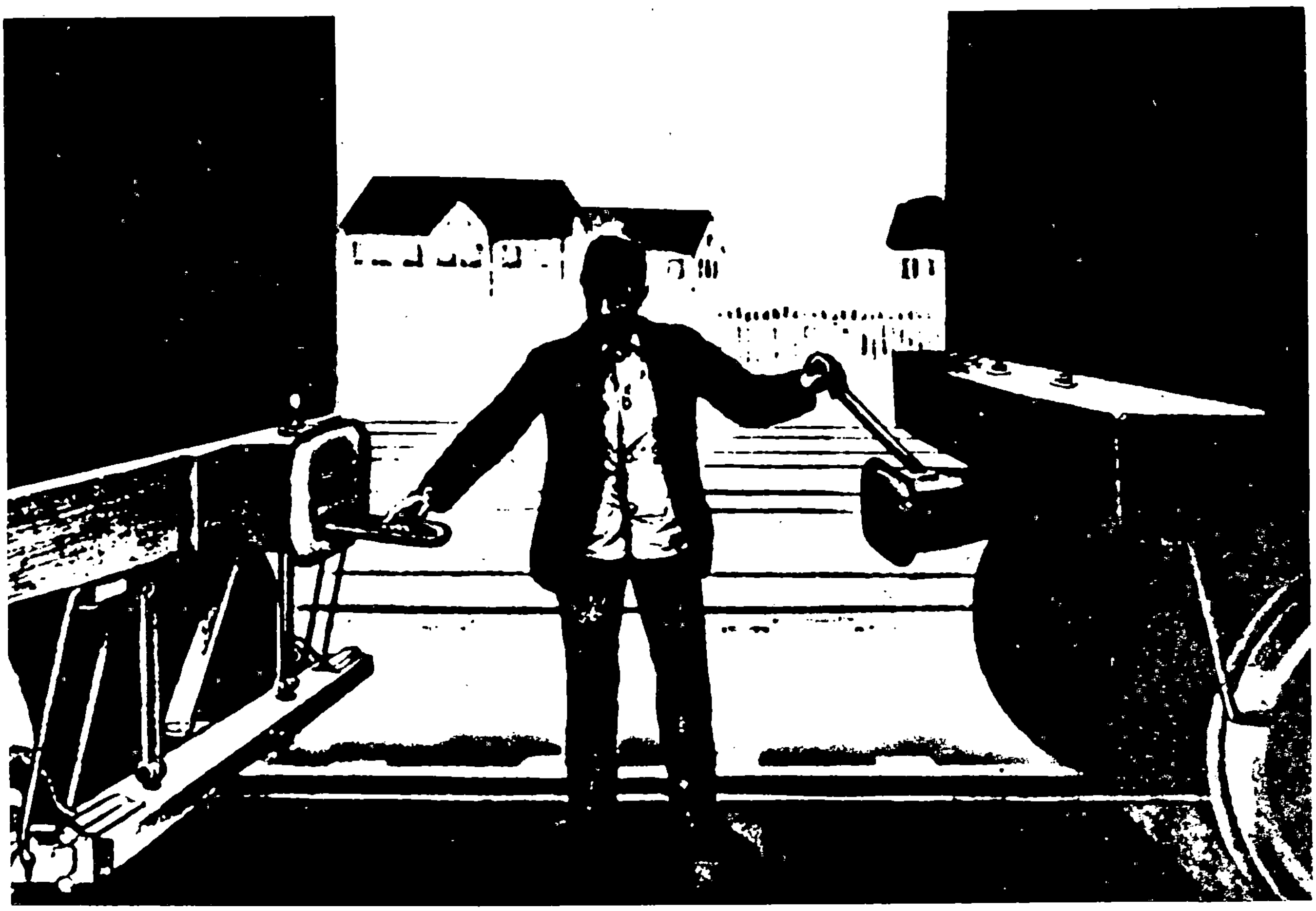


FIGURE 1-1. LINK AND PIN COUPLER

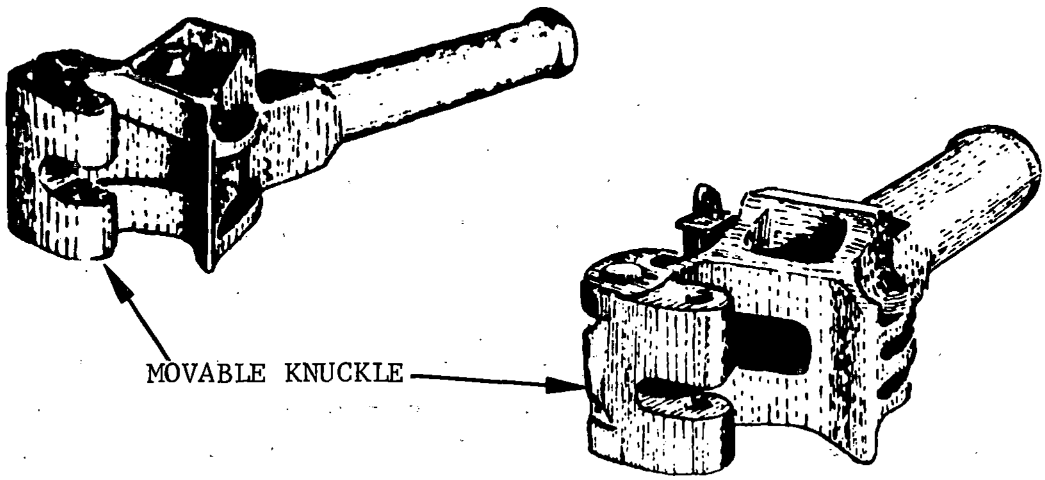


FIGURE 1-2. THE JANNEY COUPLER

Coupler problems such as free slack were determined to be related to application time and rate of buildup of the braking force in the train. Accordingly, automatic coupler development appears to parallel the development of the Westinghouse air brake (first applied for passenger service in a demonstration run in 1869) and the first patented automatic air brake in 1872.

In 1877, the Pennsylvania Railroad tested the Janney coupler and adopted it as standard equipment. This same year marks the first recorded sale of automatic air brakes for freight service. After further exhaustive tests, the Master Car Builders Association, the predecessor to the AAR, adopted the automatic coupler in 1882.

Improvements in automatic coupler design have continued up to the present day. In 1916, an improved version of the Janney coupler known as Type "D" was adopted as the standard. The Type "D" coupler featured interchangeable parts which were produced by numerous manufacturers.

Today, probably the most common freight car coupler in use on U.S. and Canadian Railroads is the AAR Type "E" rigid shank coupler. (See Figure 1-3.) The Type "E" design, which evolved from the Type "D" standard, was adopted in 1931. It offered greater strength and was easier to operate than the Type "D." In 1968 the Type "D" was restricted from use on interchange cars.

The AAR Standard Type "E" coupler has interchangeable and standardized parts and offers greater strength than the Type "D" coupler. Still, there is excess free slack between mated couplers with approximately 25/32 inches for newly installed units. The lateral gathering range is approximately 4 inches total with both knuckles open, 2 inches with one knuckle open.

During the 1940's, at the request of the AAR Committee on Couplers and Draft Gears, a joint working committee was formed to develop a general purpose freight coupler to include several design advantages of the Standard Type "E" design. The new design, identified as the Alternate Standard "F" Interlocking Coupler, was adopted in 1954 (see Figure 1-4) and can be readily

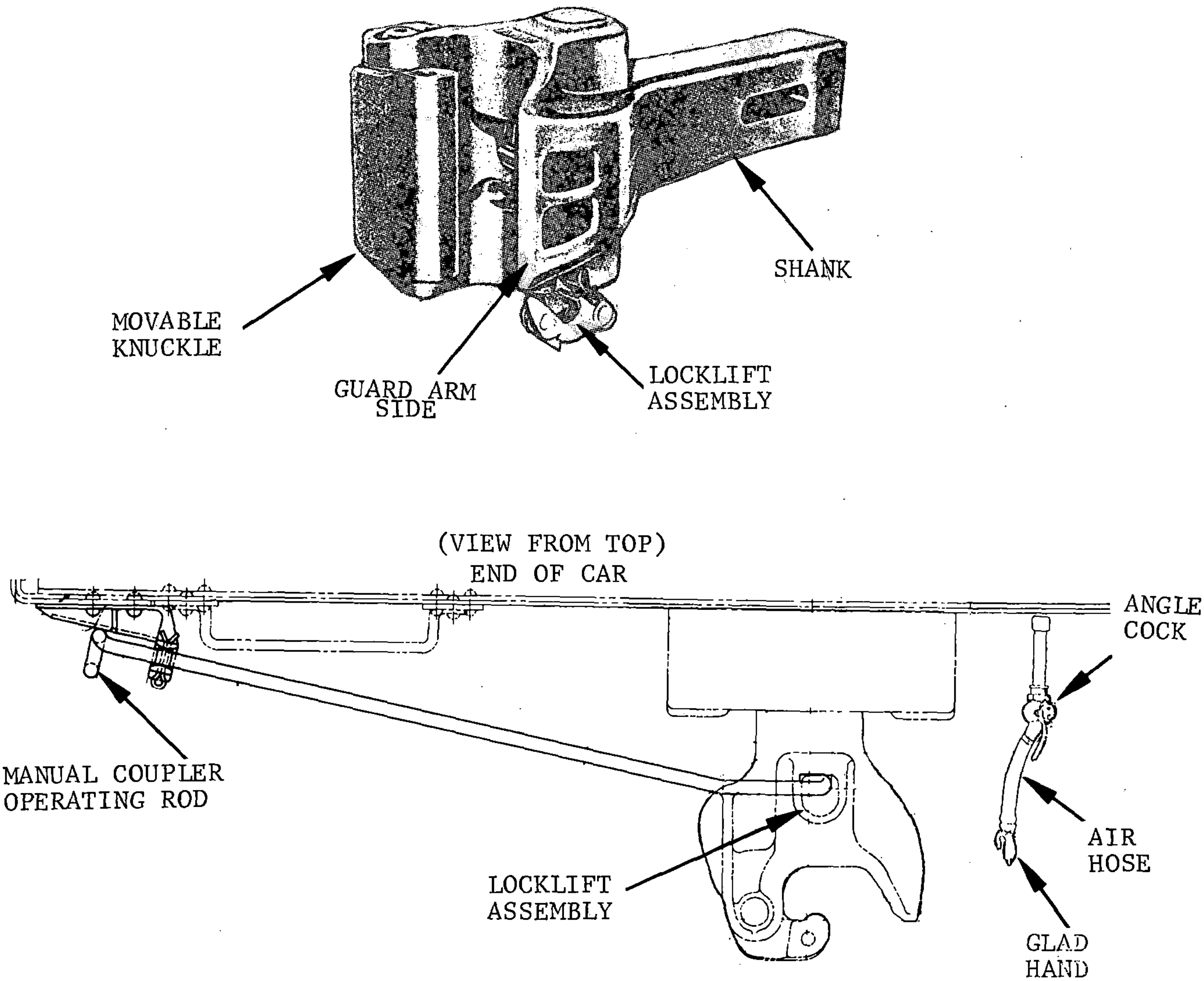


FIGURE 1-3. THE AAR STANDARD TYPE "E" COUPLER

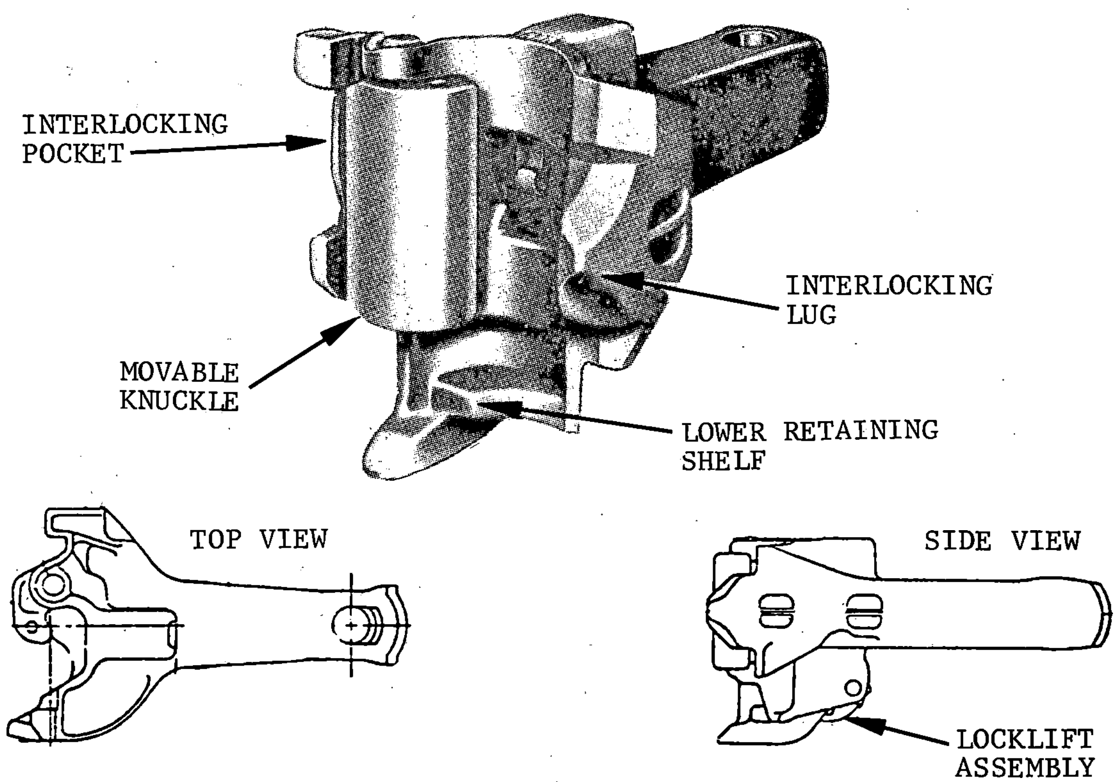


FIGURE 1-4. THE AAR STANDARD TYPE "F" COUPLER

distinguished from the Type "E" design by the cast wing pockets and interlocking lugs on the side and bottom of the coupler head. The advantages of the Type "F" coupler over the Standard "E" design include the following:

1) A 52 Percent Reduction of Free Slack Between Mating Couplers. The reduction of slack greatly improves train handling and reduces the probability of damage and run-in and run-out of slack in long trains.

2) Elimination of Vertical Slipovers. The interlocking lugs of the "F" coupler prevent relative vertical movement between the two mated couplers, thus keeping cars in alignment and preventing climbing or telescoping in the event of a derailment.

3) Wear Reduction. The virtual elimination of vertical movement between couplers, and the reduction of free slack between couplers, combine to reduce significantly the wear on mating surfaces of the coupler.

4) Protection in Case of Coupler Pull-Out. The interlocking feature of the coupler keeps a broken mating coupler from falling to the track and causing a derailment.

5) Better Distribution of Buff Loads. The alignment shoulders assist in keeping couplers centered and cars aligned under buff compressive forces.

The primary disadvantage of the "F" coupler is excessive shank failures occurring at the shank pin hole area. Compounding the problem is failure detection due to the need for complete dismantling from the suspension system prior to inspection. The "F" coupler unit cost is approximately 40 percent greater than that for the "E" primarily due to economies of scale. The lateral gathering range for the "F" is greater than for the "E". but it is still limited to approximately 5 inches with both couplers open.

Today, the type "F" coupler is used primarily on tank, extra long, and hazardous cargo freight cars - approximately 5 percent of all freight cars.

The present day mechanical coupler is often termed "automatic," meaning that the coupler automatically locks in the closed position when two cars being coupled are pushed together. However, for the coupling to be made at least one of the mating couplers must be in the open position, and the mating couplers must be laterally aligned with respect to each other so that the gathering range is not exceeded (normally 2 inches).

Problems encountered in present day coupling operations are primarily centered around the frequent situations in which the couplers do not "make," or couple, because their misalignment exceeds their effective gathering range. This occurs, for example, in gravity yard operations in which individual cars coast from the hump at relatively high rates of speed through one or more turnouts and impact with cars already humped and standing on the classification tracks. Because of vibration and lateral acceleration of the cars through the turnouts, couplers sometimes "slew" to one side and fail to have sufficient alignment upon impact with the standing cars. This situation is especially aggravated in poorly maintained classification yards in which the cars rock excessively from side to side as they approach impact, resulting in coupler bypasses.

The problems of coupling necessitate the expenditure of superfluous transportation labor costs. Strings of cars in classification yards must be physically "walked" and "made solid" before they can be pulled. After cars are coupled in industry and flat switching operations, they are normally "stretched" by the yard engine so that the crew is convinced that the couplings are made on all cars, thereby avoiding "run-away" cars.

After cars are coupled for handling in linehaul trains, the air brake hoses must be connected manually. This requires a brakeman, switchman, or airman to go between cars, straddle one rail, and reach down below the mechanical couplers and connect the air brake hoses. This operation is both time-consuming and dangerous.

The mechanical uncoupling is achieved by a trainman who opens the closed or locked coupler by activating an "operating rod" which extends from the coupler across the face of the car to an outside corner of the car. Activation of the operating rod or uncoupling lever requires that the coupler be in compression in order for the coupler to unlock. Once the uncoupling lever is activated, it must be physically held in the uncoupling position by the trainman until the two cars physically separate. In hump yard operations a "pin puller" walks with the cars about to be uncoupled as they approach the crest of the hump (where they are in buff force), activates the uncoupling lever, and continues walking with the car holding the lever up until the lead car reaches the hump.

In a flat switching operation, the trainman must perform a similar sequence, only in this case the cars are "kicked" by the yard engine to speeds sufficient for the car to coast to the end of the classification tracks. It is not uncommon, therefore, to see a trainman activate the uncoupling lever when the switch engine accelerates the cut (coupler in buff), and run with the car until sufficient kick speed is attained. At this time the engineman applies the locomotive brakes, the slack runs out, and the uncoupled car separates from the cut. This process is repeated for each car classified, exposing the trainman to danger (especially when there is moisture on the ground), and the freight cars and lading to damage due to the impact upon coupling.

Because the uncoupling levers are located on the right side of the car (as observed by standing in the center of the car and facing one end), and because the effective gathering range of couplers is increased if both mating couplers are in the open position, in flat switching yards the trainmen typically crosses over the track in front of the cut and operates the uncoupling lever with one hand and opens the knuckle with the other. When the coupler is positioned properly, he returns to the engineer's side to give hand signals to "kick" the car. While this procedure reduces the "make-solid" time, it is dangerous and time-consuming.

As the cars separate at uncoupling, the air brake hoses are placed in tension. The tension causes them to lift up, which in turn causes the "glad hand" (Figure 1-3) connections to angle sufficiently to separate. Thus, while the air hoses disconnect without manual activation, each uncoupling produces a tension strain on the air hoses and contributes to their eventual rupture. Ruptured air hoses on linehaul trains automatically cause an undesired emergency application of train brakes creating several slack action forces, and occasional derailments. Broken air hoses also create delays in road operations since the break must be located and repaired before the train can proceed.

Closely associated with the air brake hose is the air hose shut-off valve known as the "angle cock" (Figure 1-3). The angle cock is located at the top of the air hose alongside the mechanical coupler. Operating the angle cock requires the trainman to go between cars, straddle the rail, and reach over the mechanical coupler to the angle cock. Again, this requirement is dangerous and time-consuming. The angle cock is activated during the coupling when the air valves are opened. The reverse applies during uncoupling.

In summary, the operation of the present-day coupler system is not, in reality, automatic. The mechanical coupling is "Automatic" if coupler alignment is within narrow limits, if at least one of the couplers is open, and if the cars impact at the proper speed and on tangent or only slightly curved track. Air brake hose and angle cock operations in coupling are completely manual.

Mechanical uncoupling is manual, as is the angle cock operation. While the air hose disconnection can be termed "automatic," it is accomplished in a manner which subjects the air hoses to high levels of tension and high probability of eventual failure. On any given uncoupling, the probability of hose damage is low.

Thus, the coupler engagement is automatic and the air hose connection is manual in the coupling operation. The present coupling system requires a combination of automatic and manual actions for proper operation:

1) Couplers must be aligned within a 2-inch gathering range.
2) At least one knuckle must be open.
3) Cars are moved together for mechanical coupling.
4) Cars are "stretched" to verify that coupling is made.
5) Air hoses are manually connected.
6) Air valves are opened as needed.

During uncoupling, coupler disengagement is manual and the air line disconnects automatically. Uncoupling requires that several conditions be satisfied:

1) Cars are bunched (no slack).
2) Unlock coupler on at least one car.
3) Air valves are closed on each car.
4) Cars are moved apart to affect full uncoupling.
5) Air hoses are separated (automatic).

With slight modification to the coupler and air connection mechanisms, the basic freight car coupling operations have remained static since their inception - over one hundred years. It is not surprising that safety hazards, time loss, and damage are several problems still identified with present freight coupling systems.

1.3 SUMMARY

Safety problems remain a key issue - manual intervention is hazardous to the train crew during coupling, uncoupling, and switchyard operations. If couplers are misaligned by greater than the 2-inch gathering range, or if both knuckles are closed upon coupling, then the trainman must step between cars, risking injury. Similarly, air hose connection and valve adjustment always require that a trainman step between cars. In classification yards, the "pin pulling" operation involves a risk of falling near rolling freight cars.

Time losses occur in a multitude of ways. Manual connection of air hoses and operation of air valves slow the total coupling, uncoupling and switching operations. Hanging air hoses are vulnerable to damage and environmental conditions resulting in time loss during repair and replacement. Train inspection to verify couplings requires walking the length of the train and reconnecting bypassed couplers. This imposes a further time constraint. In the event of damage due to coupler bypass, significant time is lost in car repair. Also cars can be damaged during coupling if the impact is too great or if the cars are not lined up at impact.

2. METHOD OF APPROACH

2.1 GENERAL

The study approach adopted to establish significant coupler concepts which would be used to formulate candidate coupling systems consisted of establishing basic assumptions, searching literature and patents, conducting railroad industry interviews, categorizing coupler concept data, and preparing abstracts and an indexed bibliography. Each of these tasks is explained below.

2.2 BASIC ASSUMPTIONS

The definition of basis assumptions was fundamental to the advanced coupler concepts study:

1) Equipment will be limited to:
   (a) Individual cars
   (b) Mechanical and air connections
   (c) Individual car air brakes as they affect coupling or uncoupling

2) Baseline coupling system for comparison purposes - AAR Type "E"

3) New concepts must consider possibility for:
   (a) New car construction
   (b) Retrofit on old cars
   (c) Adaption of new components to fit basic system
   (d) Trains with mixture of old and new couplers

4) New concepts should be restricted to those utilizing currently available technology. "Currently available technology" is understood to include recent coupler system designs regardless of availability, and these designs need not necessarily be dependent upon a breakthrough in basic technology.

2.3 LITERATURE SEARCH

The study team conducted an extensive search of published sources of advanced coupling concepts. This literature included railroad industry technical literature, trade publications, and journal articles extracted from 21 search topics needed to interrogate the information retrieval sources for information on railroad coupling. These search topics are given in Appendix D.1.1. In addition, specific product trade names such as Willison, Unicoupler, and Compatimatic were used for further interrogation cross-referencing.

A computer interrogation using these search topics was made from the six retrieval sources noted below:

1) RRIS - Railroad Research Information Service
2) NTIS - National Technical Information Service (Lockheed Aircraft)
3) ISMEC - Science abstracts, Mechanical Engineering and Engineering Management - Part of INSPEC (Lockheed Aircraft)
4) P-TRIS - Regional Transportation Research Information Service (Transportation Center Library ~~of~~ Northwestern University)
5) COMPENDEX - Engineering Index (Lockheed Aircraft)
6) TRIS - Transportation Research Information System (Battelle Automated Search Information System)

Citations were obtained for the indicated search topics from all of the six search sources noted above. These citations (or condensed abstracts) were reviewed to obtain specific references for potential coupling concepts. Complete reference documents were obtained for each of the references determined to be pertinent to the coupling study.

For some references it was necessary to obtain additional information through the DOT library or the Library of Congress. For a few references, a translation into English was required. These documents are located in Appendix E of this report.

Where sufficient technical information was not included in the reference document, it was necessary to initiate contacts with the author or his company to obtain full specification details necessary for the comparison of coupling concepts.

Literature obtained from North American and foreign industry suppliers and railroads consisted of sales literature, specification manuals, installation manuals, and blueprints.

2.4 PATENT SEARCH

A patent search was conducted for the purpose of identifying major concepts which might have been patented but not yet developed into an actual coupling system. (Undeveloped but patented concepts would not necessarily be reviewed in the literature or discussed during visits to the manufacturers.)

The primary field of search was in the patent class 213 covering Railway Draft Appliances and subclasses within that class. Also, the most relevant secondary fields were searched, particularly class 105, covering Railway Rolling Stock, and within that subclasses 2, 3, and 4.

It was judged that a search of patents issued prior to 1960 would not be productive. Any significant concepts which had been developed prior to 1960 would have been improved upon since that time and thus would be covered with a search of patents from 1964. This has proven true in two similar patent searches done recently.

It was also found in the patent search that the significant foreign concepts had all been patented in the United States, probably because it is a major railroad country. Thus, the search of the U.S. patents did, in fact, reveal patents secured by companies from foreign countries as well as patents of the U.S. companies.

A complete listing of all classes reviewed may be found in Appendix D.3.1 of this report.

2.5 COUPLER CONCEPTS

Significant coupling concepts were identified using all of these sources and were then categorized according to basic functional characteristics. See Appendix C.

2.6 ABSTRACTS

Literature sources and patents pertaining to significant concepts were abstracted. The abstracts are contained in Appendix B.

2.7 INDEXED BIBLIOGRAPHY

A detailed, indexed bibliography was compiled to record all literature reviewed in the study. This bibliography may be found in Appendix D.1.2.

2.8 RAILROAD INDUSTRY INTERVIEWS

The literature search provided the framework for defining the industry coupler-system suppliers and any other organizations, with research and development efforts directed toward significant advanced coupling concepts. Representatives of 17 manufacturers were contacted. Additionally, it was felt that coupler users - the railroads and transit system operators - could provide valuable insights relating to current products or products used during some phases of testing. Accordingly, interviews included discussions with eight rapid transit and railroad organizations.

Telephone contact was established with personnel in all organizations selected. The telephone contacts thus provided a mechanism for:

1) Clarification of information and addition of missing data not provided in the literature.

2) Identification of areas of potential improvement for present coupling systems.

3) Discussion of supplier developments not intended for general freight service which might have possible freight application.

3. SURVEY RESULTS

3.1 CONCEPTS FOR COUPLER IMPROVEMENT

The potential list of possible improvements in the coupling interface between freight cars is virtually endless. A partial list of potential coupler improvements is included as follows:

1) Provide mechanical coupling of air lines automatically upon mechanical coupling of couplers.

2) Provide for the opening and closing of air passages as a result of mechanical coupling and uncoupling, while still maintaining the safety of emergency brake application when uncontrolled separation occurs.

3) Reduce or eliminate leakage of air at connections between cars.

4) Reduce air hose maintenance and wear rates.

5) Increase gathering range from the present 2 inches to reduce coupler bypasses.

6) Reduce and, if possible, eliminate free slack between couplers.

7) Provide means to keep knuckle open and ready for coupling, if knuckle type coupler is used.

8) Reduce contour angling to reduce jackknifing probability.

9) Provide a means of location control of couplers to reduce coupler bypasses.

10) Provide a means to prevent couplers from passing vertically.

11) Make certain that mechanical coupling will be completed regardless of minimum impact speed during coupling.

12) Provide for remote uncoupling whether on side of car, from remote position in-train, or from off-train.

13) Reduce wear and maintenance of coupler system

components.

14) Provide for an electrical train line for control or sensing to accomplish:

(a) Continuous hot-box detection.

(b) Derailment or wheel-off indication.

(c) Provision for a second air line for retaining valve operation or for other use.

(d) Automatic handbrake setting and release.

(e) Remote uncoupling.

(f) Electropneumatic braking.

(g) Slave locomotive operation.

(h) Direct communication to caboose.

(i) Operation of unloading systems (remotely).

(j) Draftgear lockout to reduce train action run-in and run-out.

(k) Communication of wayside condition detector signals through train.

At the outset of the study, an attempt was made to eliminate those potential coupler improvements which were not considered germane to the scope of work of this contract. This was done in context with the task listings in the subject contract in conjunction with technical direction from DOT/TSC and members of the AAR Advanced Coupling Concepts Committee.

The survey was directed primarily at those concepts affecting the direct interface between adjacent cars. Concepts affecting an incidental interface (e.g., electric train lines within the car system) were specifically excluded. Consideration was given, however, to such items as control techniques to be used with electric train lines.

Many elements of freight car design are affected by the coupler system. For advanced coupling systems, as defined here, consideration was given only to those portions of the freight car system which are outward from the attachment point of the coupler shank to the yoke. Essentially, the advanced coupler system analysis did not include consideration for changes in yokes, draft gear and followers, center or side sills, cushion underframe devices, or portions of the braking system internal to the angle cock.

Similarly, detailed attention was not given to incidental items which are generally considered to be support items to the basic coupling system, or for internal incidental parts for improved performance of the coupler systems, which in and of themselves were not relevant to a basic change in coupler capability. These include such elements as support chain for the air hose, uncoupling levers, and changes in design or strength of internal parts within the coupler head such as knuckle pins.

3.2 CATEGORIZE CONCEPTS BY FUNCTIONAL CHARACTERISTICS

A review of the partial list of coupler improvements given above indicates a logical grouping of these concepts in terms of functional categories. These categories involve the impact of the concepts on improvements in the train air system, mechanical coupling and uncoupling, and general train control systems. Grouping of the salient concept ideas into these four functional categories is shown in Table 3-1.

It was then necessary to standarize the data to be obtained from each of the survey sources into a uniform format. A set of standard data sheets was established which included all of the information required to define the various concepts under each of the four mechanical operational categories and to include

TABLE 3-1. CATEGORIZATION OF FUNCTIONAL CHARACTERISTICS

Mechanical Function Category	Improvement Concept
1) Improve Train Air Line System	(a) Automatic air line connection with coupling
	(b) Provide second air line system
	(c) Automatically open air valves upon coupling
	(d) Automatically close air valves upon intentional uncoupling
	(e) Automatically open air valves upon unintentional uncoupling
	(f) Improve integrity of air seal by lowering leak rates or gasket wear rates
	(g) Improve hose reliability regarding breakage, damage, or failure
	(h) Reduce hose and/or glad hand maintenance costs
2) Improve Mechanical Coupling	(a) Improve lateral gathering range of mechanical coupling
	(b) Improve vertical gathering range of merhanical coupling
	(c) Provide positive locking of mated couplers
	(d) Increase speed range at which positive coupling can be made
	(e) Reduce free slack of mated couplers
	(f) Provide vertical interlock for mated couplers

TABLE 3-1. CATEGORIZATION OF FUNCTIONAL CHARACTERISTICS (CONT'D.)

Mechanical Function Category	Improvement Concept
	(g) Absolutely entrap broken coupler
	(h) Maintain position of coupler to center of car
	(i) Reduce contour angling capability of coupler
	(j) Maintain position of coupler to center of tracks
	(k) Reduce required coupler maintenance
3) Improve Mechanical Uncoupling	(a) Improve coupling capability through the use of an alternate side lever
	(b) Improve uncoupling capability through the use of a push button release on side of car
	(c) Provide means of automatically uncoupling from within train
	(d) Provide means of automatically uncoupling from point external to train
	(e) Provide means to uncouple in draft
	(f) Improve recoupling capability by automatically opening knuckle at uncoupling
	(g) Improve recoupling capability through other means
4) Improve General Systems	(a) Automatically control brake with time delay set provisions upon intentional uncoupling

TABLE 3-1. CATEGORIZATION OF FUNCTIONAL CHARACTERISTICS (CONT'D.)

Mechanical Function Category	Improvement Concept
	(b) Automatically control brake with emergency set upon unintentional uncoupling
	(c) Provide electric train line system with automatic connection make and break
	(d) Provide electric train line system with automatic sequencing of contractors
	(e) Provide electric train line system with full environmental protection of contactors
	(f) Provide electric train line system having train sensing capabilities
	(g) Provide electric train line system having train control capabilities
	(h) Improve operational safety of coupler system

information on various related operational, safety and cost considerations. This set of data sheets was used to summarize the significant coupler concepts obtained from literature or patent searches and industry interviews. An example of the data sheet set is given in Appendix C.3. This example is completed with data obtained on one specific coupler concept and indicates the general level of detail which was available, also showing that detailed information was not available to answer some questions posed in the data sheets.

3.3 PRESENTATION OF DATA IN THE APPENDICES

Results of the survey are documented in the appendices of this report as follows:

1) Appendix A - Glossary of terms
2) Appendix B - Abstracts and patents
3) Appendix C - Significant coupler concepts
4) Appendix D - Bibliography
5) Appendix E - Translated documents
6) Appendix F - Report of inventions
7) Appendix G - Preliminary development specification for automatic train air line connector

Appendix A, glossary of terms, includes a standarized set of definitions for various coupling and railroad terms which appear frequently throughout the report. Most of these terms have the same general meaning throughout the railroad industry; however, some differ according to the geographic area in which the railroad operates. Thus, an attempt was made to standardize the meaning of the terms as indicated in this glossary.

Many different concepts were found during the various elements of search and interview. Only those which were determined to have a potential for significant impact on the total coupling system were abstracted for highlighting in this report. Appendix B contains the abstracts of these significant concepts.

The survey data indicated a number of reports, patents, or interviews which related to the same basic coupling concept. In order to aid the reader of this report and, more particularly, to aid in later engineering program development, a complete cross-reference is given relating the primary bibliography number and the other bibliographies referencing the same basic concept. This cross-reference of bibliographies is given in Appendix C. Each concept is assigned the number of the primary bibliography reference. Whenever more than one concept is derived from a particular reference subsequent letters are added to the number (i.e., 6a, 6b, 6c).

In order to establish continuity among the several types of surveys, an assignment of primary bibliography numbers was given to each of the types of literature sources searched, each of the classes and subclasses of patents searched, and each of the railroad industry suppliers and users that were interviewed. This primary bibliography reference number assignment is given in Appendix D. The references are numbered as follows:

1) Literature - Appendix D.1 (1-465)
2) Interviews - Appendix D.2 (501-559)
3) Patents - Appendix D.3 (601 - 1221)

Appendix D.1.2, gives the individual bibliography reference information for all literature searches. The bibliography of railroad industry interviews, Appendix D.2, identifies the companies that provided interviews. Appendix D.3, gives reference information for each patent search.

From the literature search it was determined that several foreign language documents apparently had significant information concerning specific coupler concepts. Five such documents were set aside for separate translation after all recognized sources for previous translations had been exhausted. These five documents are listed in Appendix E.

3.4 SURVEY CONTENT

3.4.1 Literature Search

A literature search or survey was performed to assess the state-of-the-art of coupling concepts together with the techniques for attachment of electric or pneumatic systems as part of the overall coupling system. Six of the search sources were associated with a computer memory and index system. These were: RRIS, NTIS, ISMEC, R-TRIS, Compendex, and TRIS. Of these, the RRIS search source was the most significant in terms of the depth of content and chronological time covered. The basic time frame covered by these railroad research and engineering index search sources was from 1958 through 1973. Salient bibliography references in some of these articles, however, covered reports and data from earlier periods.

Some of the reports and articles referenced the same basic concept but involved an analysis made under a different technical or time framework. A total of 52 significant coupling concepts were determined from the literature search. These have been abstracted and are included in Appendix B. Table 3-2 presents a quantitative summary of the literature search.

TABLE 3-2. SUMMARY OF LITERATURE SEARCH

Search Source	Citations Reviewed	Individual Reports or Articles Reviewed	Abstracted For a Significant Coupling Concept
RRIS	155	55	19
NTIS	12	4	1
ISMEC	14	5	0
R-TRIS	74	23	7
COMPENDEX	17	17	1
TRIS	7	17	1
AAR Manual	3	3	0
AAR Specification	4	4	0
AAR Yearbook	1	1	0
DOT Standard	1	1	0
Car Cyclopedia	1	1	0
UIC Specification	1	1	0
Bureau of Mines Reports	3	3	0
Railroad Industry Technical Publications	8	8	3
ORE Reports	6	6	0
Total	307	138	31

3.4.2 Patent Search

The primary patent class for couplers is class 213, defined as Railway Draft Appliances. Within this class, it is interesting to note that the patents granted since 1960 represent only an average of 12 patents per year and represent 3.5 percent of the total patents on couplers which have been granted. In addition, it is noted that of the limited number of patents granted since 1960, most of them cover only nominal changes to a portion of the coupling system (e.g., uncoupling linkage) which are not really significant in terms of new coupling concepts. Entire coupling systems per se are not patentable; only those individual concepts which make up the system can be patented.

Listed in Table 3-3 is a summary of patent searches which shows the class and subclasses which were reviewed, together with the number of patents which were reviewed and those within each subclass containing a significant coupling concept.

It should be noted that the majority of the patents referred to concepts also covered by bibliography references in the literature search or railroad industry interviews. These concepts, although significant in themselves, are not listed as a separate significant coupling concept but have been included under a separate primary bibliography and are shown in the cross-reference of bibliographies in Appendix B.

TABLE 3-3. SUMMARY OF PATENT SEARCH

Patent Reference Class	Subclass	Number of Patents Searched	Abstracted For a Significant Coupling Concept
46	241	1	
74	527	1	
104	26R	1	
104	172	1	
105	3	4	1
105	4	14	
213	1.3	13	5
213	1.6	2	
213	8	1	
213	15	12	2
213	63	1	
213	72	5	
213	75	3	1
213	75D	1	1
213	75TC	1	1
213	76	17	9
213	100	24	3
213	103	1	1
213	104	1	
213	110	4	1
213	111	1	
213	112	6	
213	127	1	
213	133	1	
213	142	1	
213	144	1	
213	145	1	

TABLE 3-3. SUMMARY OF PATENT SEARCH (CONT'D.)

Patent References		Number of	Abstracted For a Significant
Class	Subclass	Patents Searched	Coupling Concept
213	147	2	
213	148	1	
213	151	6	4
213	152	3	2
213	153	4	3
213	154	1	
213	158	2	
213	159	5	2
213	162	5	
213	166	22	1
213	167	2	
213	168	2	
213	211	9	1
213	212	7	5
213	217	1	
213	219	5	2
285	12	2	
339	15	1	
339	48	1	1
Total		201	46

3.4.3 Industry Interviews

During the initial search effort involving both literature and patents, it was determined that specific quantitative details were frequently not present in the supporting data included with the technical document. In general, the technical discussion concerning the coupling concept would describe only the qualitative merits of the concept without giving adequate technical information for a quantitative measure of the value of the concept. Moreover, in the case of some of the literature search documents, it was necessary to separate out the rhetoric of salesmanship, which in some cases described the capabilities of the concept in terms beyond that which seems technically feasible. From these earlier searches it was determined that first-hand interviews were required in order to obtain the necessary quantitative data needed to evaluate most of the concepts. Thus the industry interviews became a more important part of the overall survey than was originally anticipated.

In the case of concepts with a foreign origin (excluding Canadian), it was not deemed appropriate or necessary to schedule personal interviews. The reasons for this decision were:

1) There was a greater abundance of detailed technical literature of European concepts than on those in the United States.

2) European development efforts have been directed for the past 25 years at development of coupler systems which would meet the UIC synthesis design for a universally applicable coupler system. Thus the European design concepts centered on the attainment of a single coupling goal and therefore tended to overlap in technical approach.

3) The primary U.S. railroad suppliers are involved

through subsidiary or consortium contacts with the major design efforts in Europe.

The complete bibliography of railroad listing interviews is given in Appendix D.2. As was the case with the patent search activities, a great many of the coupling concepts uncovered during industry interviews, although significant, were included in other significant concepts listed under literature search primary bibliography numbers. The following is a list of industries interviewed.

1) American Steel Foundries
2) National Castings Division, Midland-Ross Corporation
3) Ohio Brass Corporation
4) General Foods Corporation
5) Canadian Steel Foundries
6) Hawker Siddeley Canada Ltd.
7) Stanray Corporation
8) Holland Company
9) McConway and Torley Corporation
10) Buckeye Steel Castings
11) Westinghouse Air Brake Division, WABCO
12) Evans Products Company
13) Dominion Foundries and Steel Limited
14) New York Air Brake Company
15) Freight Master
16) Walton Products
17) Dresser Transportation Equipment Division, Dresser Industries, Inc.
18) San Francisco Bay Area Rapid Transit System
19) Cleveland Transit System
20) Southern Railway
21) New York City Transit Authority
22) Chicago Transit Authority

23) Atchinson, Topeka and Santa Fe Railway Company
24) Washington Metropolitan Transit Authority
25) Canadian National Railways

3.5 SIGNIFICANT CONCEPTS

As a result of the literature and patent searches and the industry interviews, 108 separate significant coupler concepts were identified. A listing of the significant concepts and identification of the mechanical function category impacted by each concept is given in Table 3-4. A more detailed listing of concepts (categorized by impact on functional characteristics) is given in Appendix C.

3.6 CONCLUSIONS

Several specific conclusions can be drawn from a review of the technical data obtained in the survey:

1) In the United States, development efforts leading to patent application or published technical data on new concepts has been diminishing over the last 15 years as compared to previous times.

2) The decrease in U.S. development efforts has coincided with the decreasing usage and profitability of the American railroads.

3) In general, recent significant technical advancements have been patented. However, the necessary development work required for product marketing has been set aside, primarily as a result of an uncertain market for new concepts.

TABLE 3-4.-SUMMARY OF SIGNIFICANT

CONCEPT NUMBER	CONCEPT IDENTIFICATION
6a	Grimesthorpe ASF/V Coupler
6b	Gresham and Craven Air Connector
8	S-W Coupler Positioning Device (Mechanical Linkage, for Existing Cars)
9	S-W800 Coupler
22	Dresser Automatic/Pneumatic Coupling System
25	S-W "LC" Coupler
26	Controlled Swivel "E" Coupler
27	Dresser Rapid Transit Coupler
31a	S-W Positioning Device (Hydraulic Master-Slave, for Existing Cars)
31b	S-W Positioning Device (Hydraulic Guided, for New Construction)
33	Eurocoupler 68
36	British Wedglock Coupler
41a	Holland Positioner Device
41b	Evans Centering Device
41c	Evans Positioning Device
	Stanray Centering Devices:
41d	Coil Spring Type
41e	Double Leaf Spring Type
41f	Double Coil Spring Type
41g	Swing Type
45a	SNCF Double-Lip Seal Air Connector
45b	SNCF Vacuum Brake Bleed System
45c	Khoeps Electric Connector
47a	Simplified U.I.C. Coupler (French)
47b	Pendulum Self-Centering System
52	Type "E" Coupler with Top Shelf
54	Type "E" Coupler with Top and Bottom Shelf
254	Walton "Electro-Pneumatic" Control System
301a	Willison Type II (U.I.C.) Coupler
301b	Scharfenberg Kupplung
306	Freightmaster Positioning Device
309	Unicupler (U.I.C.) Coupler
318	ORE II Cross-Beam Centering Device
387	German U.I.C. Electrical Control
391	Osaka Coupler System
428a	Standard AAR "H" Tightlock Coupler
428b	Standard AAR "F" Interlocking Coupler

COUPLER CONCEPTS

MECHANICAL FUNCTION CATEGORY			
I IMPROVE TRAIN, AIR LINE SYSTEM	II IMPROVE MECHANICAL COUPLING	III IMPROVE MECHANICAL UNCOUPLING	IV IMPROVE GENERAL SYSTEMS
	X	X	X
X			
	X		X
X	X	X	X
X			X
	X		X
	X		X
X	X	X	X
	X		X
	X		X
X	X	X	X
X	X	X	X
	X		X
	X		
	X		X
	X		
	X		
	X		
	X		
X			
			X
			X
	X	X	
	X		
	X		X
	X		X
X		X	X
	X	X	X
X	X	X	X
	X		X
X	X	X	X
	X		
			X
X	X	X	X
	X	X	X
	X		X

TABLE 3-4.-SUMMARY OF SIGNIFICANT COUPLER

CONCEPT NUMBER	CONCEPT IDENTIFICATION
434a	Cobb "Horn-Funnel" Air Connector
434b	Francis "Cone-Ring" Air Connector
448a	Ohio Brass Form 8 Coupler
448b	Ohio Brass Form 9 Coupler
449	Alternator-Battery Electrical Power System
450a	Ohio Brass Form 8A Coupler and Control System
450b	Microwave Transmission Control System
451a	National "Ball-Funnel" Air Connector
451b	Robinson "Pin-Funnel" Air Connector
451c	Roberts "Spread-Wing" Air Connector
451d	Johnson "Scoop-Knob" Air Connector
451e	Compatimatic* "Spread-Wing" Air Connector
451f	American "Horn-Funnel" Air Connector
452	Dresser "ESACS" Control System
457	Dowty Automatic Central Coupler
458	Robinson "Spread-Wing" Air Connector
501	A.S.F. Coupler Knuckle Contour Change
502a	National Castings I.G.R. Coupler Knuckle
502b	National Castings "Compatimatic" Coupler
502c	National Castings Air/Electrical Connector
502d	Willison Mine Car Coupler
503a	Ohio Brass Form 70 Coupler and Control System
503b	Ohio Brass Form 29 Coupler System
503c	Ohio Brass Form 73 Coupler System
503d	Ohio Brass Form 5 Coupler System
511a	WABCO N-2 Mass Transit Coupler System
511b	WABCO Train Air Line Connector
511c	WABCO Train Line Electrical Connector
516a	Walton Automatic Coupler
516b	Walton Electrical Control Box Systems
601	Campagnia - Electrical Connector
603	Automatic Service Line Connector
605	Automatic Trainline Connector
606	Dresser Electric Coupler
610	Midland Ross Retractable Trainline Connector
611	Midland Ross Retractable Trainline Connector
650	Automatic Uncocking Recocking Mechanism
670	Westinghouse Automatic Hose Connector
671	ACF Trainline Valve Means
672	Automatic Air Coupling Structure

Note: (*) Developed by National Castings Division, Midland Ross Corporation.

CONCEPTS (CONTINUED)

MECHANICAL FUNCTION CATEGORY			
I IMPROVE TRAIN, AIR LINE SYSTEM	II IMPROVE MECHANICAL COUPLING	III IMPROVE MECHANICAL UNCOUPLING	IV IMPROVE GENERAL SYSTEMS
X			X
X			X
	X	X	
X			
			X
		X	X
		X	
X			X
X			X
X			X
X			X
X			X
X			X
			X
X	X	X	X
X			X
	X		X
	X		X
	X	X	X
X			X
	X		
X	X	X	X
	X		X
	X		
	X		X
X	X	X	X
X			X
			X
X	X	X	X
			X
			X
X			
			X
			X
X			X
X			X
		X	
X			
X			
X			

TABLE 3-4.-SUMMARY OF SIGNIFICANT COUPLER CONCEPTS (CONTINUED)

CONCEPT NUMBER	CONCEPT IDENTIFICATION	MECHANICAL FUNCTION CATEGORY I IMPROVE TRAIN, AIR LINE SYSTEM	II IMPROVE MECHANICAL COUPLING	III IMPROVE MECHANICAL UNCOUPLING	IV IMPROVE GENERAL SYSTEMS
674	Dresser Coupling Valve Actuator			X	
676	Automatic Coupling System for Freight Cars				
678	Dresser Automatic Pneumatic Coupling System			X	
680	Midland-Ross Trainline Connector	X			
682	Dresser Brake Line Coupler	X			
686	Armsted Automatic Air Line Connector	X			X
702	Armsted Railway Coupler		X		
703	Indian Automatic Coupler		X		X
705	Midland Ross Railway Coupler		X		
740	Amsted Railway Car Coupler			X	
760	Midland Ross Car Coupler			X	
761	Midland Ross Car Coupler			X	
890	Amsted Knuckle Structure		X	X	
891	Amsted Knuckle Structure		X		
892	Midland Ross Knuckle Contour		X		
895	Midland Ross Knuckle Contour		X		
900	Midland Ross Coupler Shelf		X		
901	Coupler Knuckle				
910	Interlocking Coupler		X		
912	Midland Ross "F" Coupler Hood		X		
913	Amsted Interlocking Coupler		X		
940	Southern Pacific Brush Uncoupler			X	
943	Dresser Fluid Uncoupling Mechanism		X	X	
960	Holland Uncoupling Lever			X	
1020	Japanese Robot Uncoupler			X	
1043	Nippon Automatic Release			X	
1044	Nippon Car Disconnector			X	
1045	Hines Remote Control Uncoupler				X
1046	Symington Fluid Operated Uncoupler			X	
1061	Keystone Uncoupling Mechanism			X	
1063	Railway Car and Coupling Device				
1070	Spanish Wheel Guidance Actuating Device		X		
1100	Coupler-Positioning Device for Railway Car-Couplers				
1101	Coupler-Positioning Device for Sliding Sill Cushioned Underframe Cars				
1140	Bissett Magnetic Coupler				
1150	Southern Pacific Coupler Opener				
1160	Electrical Circuit Control Apparatus				
1190	Keystone Coupler Centering Draft Gear				
1200	WABCO Hose Connector				

4) The interviews indicate that no recognized industry supplier is working on any revolutionary new concepts.

5) Significant development effort has been applied in Europe over the last 25 years for the development of a standard coupler to meet the requirements of the UIC Synthesis coupler standards.

6) A great deal of the European development effort has been aimed at developing transitionary components needed for "mixed" couplers of the old hook and screw type as they would mate the new UIC Synthesis couplers.

7) Most of the European coupler effort has been aimed at modifications of the basic Willison coupler design, a rigid-knuckle type.

8) Most of the European development work for air or electrical connectors has been associated with their use as an integral part of the final rigid coupler design. This differs from the U.S. developments in this area, which have been concentrated in the area of separate air connection devices.

A sufficient number of new coupler concepts has been uncovered to derive coupling systems which represent a significant improvement over the present system.

4. OPERATIONAL CHARACTERISTICS OF CONCEPTS

4.1 DESCRIPTION AND EVALUATION OF SIGNIFICANT COUPLER CONCEPTS

Each of the significant coupler concepts listed in Table 3-4 were subjected to a detailed evaluation. This evaluation was based upon the primary bibliography reference to the concept and, in addition, the secondary or other bibliography references including information on this same concept.

A detailed data sheet was established to show both the description of the system and an evaluation of the significant coupler concepts included in the basic system. These data sheets are shown in Appendix C.3 of this volume. These evaluation data sheets included a brief description of the basic concept, an indication of compatibility with the basic AAR type "E" coupler system, related bibliography reference numbers, and an engineering evaluation of the concept as related to each of the previously defined operational characteristic categories. In the evaluation section for each category a check was made of each of the pertinent functional characteristics impacted within that category by the concept. Appendix C.1 defines the functional characteristics by category. In this evaluation, wherever there appears a potential operating or safety problem inherent in the concept, the evaluation comment is preceded by a double asterisk (**).

An explanatory note is in order concerning the compatibility of each concept with the AAR Type "E" system. It is recognized that every coupling system concept could be made to "fit" into a Type "E" system by the use of an adapter system. From this viewpoint, each concept is "compatible." For this study, however, four levels of compatibility are defined as follows.

1) Can be added to Type "E" - results in a separate attached unit (like an air connector)

2) Modification of Type "E" - requires a change to the coupler which does not interfere with mating with regular "E" units.

3) Requires head adapter for Type "E" - A different type or style of coupler which would require an adapter system to couple with an "E" unit.

4) Incompatible with Type "E" - A totally different coupling system requiring a complete adapter system to couple with an "E" unit.

4.2 ENGINEERING EVALUATION OF OPERATIONAL CHARACTERISTICS OF ALTERNATIVE CONCEPTS

As the next step in the assessment of the coupling concepts, the evaluation data noted above were subjected to an engineering review to define the effects of the concepts on operational characteristics. These effects were then analyzed in terms of impact of the functional characteristics upon the separate system categories previously established. This engineering review and analysis is summarized below.

4.2.1 Train Airline System (Category I)

It is desirable to have a system which provides an automatic air-tight connection between adjacent cars coincident with the mechanical coupling process. The system should be adequately mounted to be able to withstand the abuse that occurs in rail freight service. In addition, it is desired that the air connection system automatically operate the train air valves to provide continuity of the air line system at coupling. The system should apply emergency brakes during any unintentional uncoupling while maintaining control of braking during intentional uncoupling.

4.2.1.1 Air Connector (Add-On Unit)

1) Location: Because of the requirement for coupling on curves, it was determined that air connectors located at any point lateral to the center line of the coupler were subject to potential malfunctions resulting from damage as a result of a coupling bypass.

Positioning the air connector above the coupler head is not deemed to be a feasible alternative. In piggyback applications, it is an operational requirement in circus loading that trailers be driven horizontally from the top of one flatcar to the next. This requires a dock plate or other platform to be laid across the top sills of adjacent cars. Although the wheels of the trailers will straddle the area immediately above the coupler head, there is potential for trailer parts or pieces to extend very close to the bottom of the trailer. Railroad operating personnel have neither control nor advance knowledge of devices hanging down beneath the trailers. Any external air connector mounted above the coupler head would thus be in jeopardy of damage during such trailer loading operations. Since piggyback operations are expected to be an increasingly important segment of rail freight cargo, any attached air connector unit should be located below the coupler head.

A lower suspended unit does present problems. In this position, the air connector will be subject to an excessive amount of dust, dirt, or other material emanating from the roadbed between the tracks. The air connectors must therefore be designed to be free of close-tolerance or sliding components which would have a tendency to bind or seize as a result of a buildup of this road grime.

2) Mounting: There are three optional methods for mounting or attaching the air connector: direct attachment of the connector to the coupler head; attachment of the connector to the end of the car body, cantilevered for total self support; or attachment of the connector by means of an attachment to the coupler head.

The second alternate design is not found to be feasible because of problems of extreme weight and potential harmonic vibration damage to the air connector. Either of the other two methods of support seem feasible.

In general, a coupler-supported air connector should weigh less and be shorter than an air connector supported by the end of the car and guided by the coupler.

Designs of both types have been proven to work acceptably. As a general rule, however, good cost-effective design engineering dictates the use of the lighter, simpler coupler-head-attached system.

The design of the connector attachment and support system must be such that no pulling pressure is applied to the air connection hose system as a result of vibration or oscillations of the coupled units. In addition, the design of the mounting brackets must allow the free movement of the connector head back against the seating spring without any rubbing or interference between the air pipe or hose system and the mounting brackets.

3) Type: Two basic types of gathering devices have proven feasible: spread-wing type and pin-funnel type (including ball-funnel, horn-funnel, and cone-funnel). Designs of both of these types have passed development tests and indicate a feasibility for rail freight application.

It has been found that the design of the gathering mechanism must be as symmetrical as possible and as free of points of discontinuity or other abrupt curvature changes. Rectangular shaped pin-funnel type connectors, in general have a greater number of changes in curvature and slope with a resulting large number of points at which the horn can bind at the time of entering the funnel. Any point of significant binding will result in a propensity to gall or score the surfaces of the gathering pieces. The end result will be that the air connectors will have a tendency to stick open or to bind up and then "jump into place" after the galling forces are overcome by the spring pressures.

The latest designs of the spread-wing type, on the other hand, have gathering faces which are "clean" in design. Thus there is a smooth movement during gathering, which reduces the possibility for a hang-up of one of the gathering elements with the mating unit.

The spread-wing type air connector is thus judged to be the best of the design alternatives which were reviewed. The current connectors of this type are somewhat smaller and lighter than those tested in the mid-1930's by the AAR Technical Center. Wing design improvements have been made to achieve a better taper of the leading edges to minimize the frictional resistance while mating. Current designs using high alloy steel are also stronger than earlier tested units.

4) Gathering: The gathering mechanism of the air connector must be sufficiently rugged to withstand both the lateral gathering forces and the longitudinal coupling forces without deformation. The design of the mounting and gathering elements must be such that, during normal coupling operations, the knuckle of the "E" coupler head will touch first to absorb the majority of the coupling forces prior to the air connectors coming into contact.

For air connectors designed for use with the "E" type coupler, both the mounting and the gathering must have increased range. That is, the "E" type coupler has a large vertical movement as well as 0.78 inch of free slack. Thus, an airline connector designed for use with an "E" system must have greater flexibility and gathering range than one designed for use with the "F" type coupler system, which has a better vertical gathering capability and a highly limited movement of joined couplers. In the case of the "F" type air connector, the coupler accomplishes almost all the gathering and the "wings" of the air connector must only complete the final centering or gathering of the airline connector.

Another requirement for air connectors is that their gathering action must be completed in front of the air seals such that any lateral gathering motion is completed prior to the final seating of the air seals. Because of the tremendous forces involved in the mechanical coupling of freight cars, any lateral gathering motion within the air connector after the air seals have made contact will result in an undue and excessive scrubbing force applied laterally to the compression seals.

5) Sealing: Two types of air seals were reviewed: butt faced seal, in which the air seal is placed at right angles to

the center line of the car; and an angular faced seal, in which the seal faces are placed at an angle (usually 45 degree) to the center line of the car, such that both longitudinal and lateral movement is required for the seals to come into complete contact. The butt type seal was determined to be the only type having consistent and reliable operation.

The "E" type coupler has a significant amount of free slack, and, to a lesser extent, the "F" type coupler (0.37 inch free slack). Even the "rigid" type coupler systems (such as concepts 6a, 9, 36, 30lb must have some amount of free slack in order to allow proper coupling under conditions of ice and snow buildup. Thus air connectors (as well as electric connectors) must have their own compression-loading capability in order to compensate for this free slack or movement between coupled units. It has been determined that both a pliable compressible seal unit and a backup spring-type system are required to make good initial sealing and to maintain sealing throughout the coupling and environmental changes. To compensate for wear of the connector seal (expected as a result of impact erosion or gathering arm wear) or buildup of road grime, the air connector seals should have a compression of a least 0.25 inch and have backup springs having at least 1.5 inches of compression which would force the air connector seal in the forward position at all times to compensate for uneven mating couplers.

6) Maintenance: For ease of maintenance during road or switching operations, it is desirable that the air connector gaskets be removable from mated units. Thus, the air connector design must logically provide for removal of the sealing elements from the rear of the air connector units. Since each removal would involve a severe bending or moving of the entire air line system, it follows that the air connection system should have a

minimum number of joints in order to minimize the possibility of leakage following such seal repair efforts.

It is necessary to provide for the adaptation of an automatic-air-connector-equipped car to an unequipped car. Additionally, this attachment of a "mixed" air connector system should be accomplished without the aid of special tools or the need for a second workman. Some of the "mixed" connection systems were heavy and bulky, resulting in considerable difficulty experienced by trainmen in maneuvering and attaching the "mixed" air connector systems. In addition, it is necessary that the air connector head allow for sufficient flexibility to avoid excessive distortion or twisting of the air hose on the unequipped car. Thus, if the air connector is to provide for adapting directly against the air connector head, it is necessary that the air connector unit have some form of horizontal pivot in order to provide for the required flexibility. Considering the complexity of the separately detachable "mixed" connector heads and the potential for a poor air seal resulting from pivoted air connector heads, it is concluded that the best possible "mixed" air connector system involves the use of a separate air hose/glad hand unit which operates in the same way as the current air hose connector system. (Concepts 1192 and 1193.)

The most simple and readily adaptable proven system for accomplishing the requirements for connecting "mixed" air connector systems is the separate air hose/glad hand system incorporated in Concept 22. In this system the "mixed" adapting unit is identical to the standard train air line hose and is connected to the basic air pressure line system by use of a standard train air line valve. Thus the system is simple, relatively maintenance free, and consists of components of proven reliability.

7) Summary: Several air connector concepts which were reviewed incorporated the basic operating principles determined to be important for proper operation of the system. These include Concepts 22, 451e, 502c, and 511b, which are all currently designed units. These all represent second-generation units utilizing the basic design concepts of the Robinson spread-wing air connector (Concept 458).

None of the preferred air connector designs contain all of the desired features intended for a railroad operating environment. There is no reason to believe, however, that each of these designs could not be modified and the design improved as necessary to make an acceptable air connector system.

4.2.1.2 Air Connector (Integral Unit)

In the "E" type of coupler system, there is no room within the face of the coupler head to build in an integral air connector unit. In addition, there would be problems in maintaining the seal of an air connector unit because of the allowable vertical and lateral movements of the connected type "E" coupler systems using the AAR type "F" head. Thus, air connectors for use with the present free knuckle coupler system must be of the add-on type as noted above.

An alternate concept of coupler system is the "rigid" type (such as Concepts 9, and 36). By definition, the "rigid" type of coupler head system does not have a relative movement or free slack between the joined couplers (considering wear and other field usage problems, free slack may be a few one-thousands of an inch). This type of "rigid" coupler head system can utilize an integral air connector unit.

1) General Design: This type of air connector unit could be located anywhere within the general outline of the "rigid" coupler head. To compensate for any possible free slack in the system which might result from wear, it seems desirable to have the air connector located on the vertical centerline of the coupler head and as near as possible on the horizontal centerline. This will minimize any relative movement between the connector seals which might result because of wear or misalignment in the coupler head system.

The mounting location for the air connector preferably should be recessed within the face of the coupler head. This location is desired for two reasons:

(a) The air connector seals are better protected from accidental damage while they are in the uncoupled condition.

(b) The connector seals should be recessed sufficiently deep in the face of the coupler head so that all lateral and vertical gathering movements are completed and the coupler heads are moving only in a tangent position one to the other before the faces of the air connector seals come in contact.

In this type of integral air connector system, the entire movement for gathering is accomplished by the coupler head. Therefore, the air connector has no gathering features by itself.

The type of seal for the integral unit should have the same general characteristics as for the add-on unit. In particular, this means that the seal should be of a compressible resilient type of material and that it should be backed up by a spring-type compressing seal. In a similar sense, it was determined that a butt type of seal was required for a good sealing reliability.

This type of air connector design is similar in maintenance

3) Summary: Of the train air valve control systems associated with an add-on air connector system, only Concept 22 meets the desired criteria as outlined above.

4.2.1.4 Air Valve Operation (Integral Unit)

The air connector system described in Section 4.2.1.2 defines an integral air connector unit contained within a rigid type of coupling system. This type of rigid coupler system is generally considered to be associated with the adaptation of a train electrical control system. However, it is feasible that this type of coupler unit could be utilized without an electrical system and therefore the control mechanism for the air valve operation should assume both electrical and pneumatic options as well as direct mechanical operation.

1) Mechanical Operation: This integral type of air valve operation should likewise be direct, simple, and have fail-safe provisions. Initial operation of the airline valve should be initiated by a direct push rod actuated at the time that the coupler comes into the mating position. The most desirable operation would be a direct push rod from the coupler head to the first valve as compared to a more complicated system involving movement of cam shafts, linkages, or a more complicated connecting device.

The valve operation should be such that, once the airline valve is open, the valve remains in the open condition unless there is a positive indication of uncoupling such as operation of the uncoupling rod or other remote signal. A fail-safe provision for an emergency brakeset condition is mandatory for an unintentional uncoupling situation.

2) Control System: If only air pressure is available in the train line systems, the pilot line/train airline valve system noted in Section 4.2.1.3 seems to be the most direct and reliable system. A pneumatic control system that depends upon vacuum differential pressures would seem to be of doubtful reliability as applied to a full long train under expected adverse environmental conditions. This type of system (Concept 45a) depends on small vacuum differentials to accomplish certain valve operations with larger vacuum differentials (or longer time durations) operating the valves for a different mode of control. Such a system would would be less reliable and have less fail-safe potential than a positive pressure system operating from reduced pilot line pressures.

Where a train electrical line system is available for control, the basic valve operation system should still be based on the pneumatic control valve operation. In such a system the electric solenoid valve would operate the pilot valve only for those situations involving a remote control signal for uncoupling. In all other respects, this system would be most reliable if the remaining elements were identical to the pneumatic system described above.

Several references reported difficulties with proper operation of electric solenoids when the solenoid plungers became rusty or free movement of the plunger was restricted by environmental contamination. Thus, any system involving electric solenoids should include a total environmental protection of the unit in a sealed retaining system.

Direct operation of the train airline valves by electric solenoids was reported to be subject to difficulty where sticking valves required undue force to operate, demanding an excessive amount of electrical current from the electric solenoid control system. Thus the all-electric valve control system presents the potential for significant reliability problems.

3) Summary: Several system concepts reviewed utilized some portion of the desired characteristics noted above. Concepts 9 and 503a shared the same concepts presented by the electro-pneumatic control system Concept 254 which is chosen as the most desirable control system. It encompasses the need for an all-pneumatic control system and an electropneumatic system while retaining the mechanical control features of direct operation from a coupler rod or uncoupling lever.

4.2.2 Mechanical Coupling (Category II)

Before evaluating the applicability of various coupling concepts, it is appropriate to review some of the basic requirements for coupling systems. The coupler must provide for automatic coupling and uncoupling and must have adequate load carrying capability as required for general freight service. The coupler system must be mechanically rugged and capable of withstanding the full range of environment, temperature, and element extremes. For both universal application and safety reasons, the coupler system should not require any external energy (pneumatic or electrical) for completing the coupling process. It is desirable that the basic coupler system be adaptable for later modification to include air or electrical functions.

The basic coupler concepts are readily grouped into two distinctly different design types. These are represented by a "free" coupler system and a "rigid" type system. Schematic outlines of these two systems are shown in Figures 4-1 and 4-2.

In the "free" automatic coupler system (as depicted in Figure 4-1), two connected couplers are free to slide vertically in relation to each other and are not securely held together in a manner which prevents any free slack or play between the connected units. This free movement between the couplers allows for the coupler head to slide in a vertical direction to compensate for differences in car heights or intercar movements caused by normal train operation. The AAR Type "E" coupler system is the basic "free" coupler system concept which was used as the basis for all other coupler concept comparisons. Automatic connection of airlines cannot be accomplished with a "free" coupler head.

Of course, it should be realized that very few coupling concepts fall 100 percent in either one of these two types. However, the basic "free" and "rigid" designation appears quite realistic as a natural grouping of two types of connection systems.

4.2.2.1 Noncompatible With Type "E" System

Several design concepts were reviewed which were not compatible with the current "E" coupler system. These all fall in the "rigid" or "semirigid" type of coupler systems.

Within this basic type of coupler, there are two distinct design types: flat-faced and spread-claw type. Each of these two types of couplers are unique in their ability to utilize integral air and electrical connections. Since this noncompatible type of coupler would represent a radical departure from the Type "E" system currently in use, it is believed appropriate that a more severe design requirement should be placed on such a

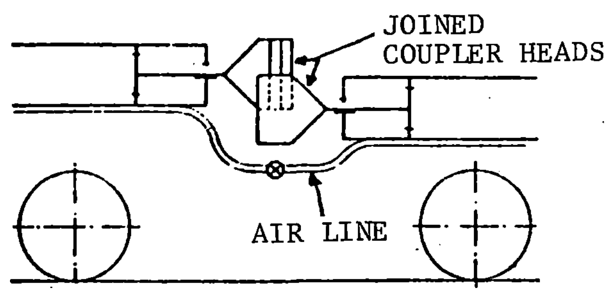


FIGURE 4-1. "FREE" COUPLER

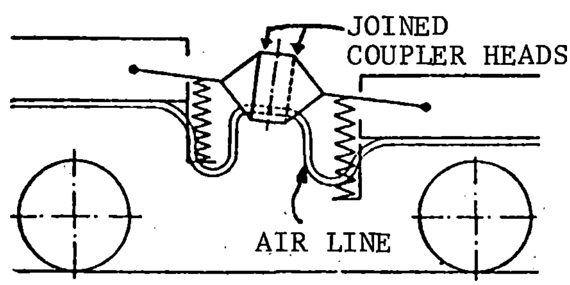


FIGURE 4-2. "RIGID" COUPLER

new unit with respect to its adaptability to the use of an air or electrical connection system which might be added at a later time.

A general summary of user comments relating to the flat type "rigid" coupler indicates this type of design to be more readily adaptable to integral air and electrical connections. On the other hand, this type of design is inherently more expensive because of the added complexity and machining. This type also appears more susceptible to malfunction because of the sensitivity of the machined edges to impact damage upon coupling. This type of unit also apparently requires greater overall weight in order to achieve an equal strength.

The spread-claw type of "semirigid" units all represent a modification of the basic Willison coupling principle. The basic design of the Willison involves a discontinuous lateral movement at the time of coupling. This concept presents a potential for difficulty in integral attachment of air and electric connectors as will be noted below. In other respects this design type appears to offer a more cost effective design in terms of the use of large single cast units with a minimum of machining and represents a stronger design in strength to weight ratio.

Flat switching operations compose approximately 80 percent of all coupling operations. Although most hump yards are highly automated, a tower operator normally watches the humping operation and has the power to override the computer system (for control over the retarders) if he has reason to think that the electronic control will not give the car proper speed. The incentive in both a flat switching and hump switching operation is to insure positive coupling rather than to allow a car to fall short. The inevitable result is coupling at excessive speed.

Sample test programs have shown average impact speeds for yard operations to be within the "rough" range of 5 to 9 mph.

In Willison type couplers having a discontinuous coupling movement, the higher coupling speeds are transmitted as greater impact energy both tangent to the line of car movement and laterally. This lateral energy is imparted to both the fixed elements of the coupler head and to any associated air or electric connector units which are an integral part of the coupler head. Thus, the potential for damage (particularly to electrical connector units) is significant if any portion of the lateral movement of the discontinuous coupling takes place after the initial engagement of the electrical or air connector.

Some of the most recent modified Willison designs (Concept 309), do make provisions for completion of the lateral discontinuous coupling movement before a final longitudinal movement to complete coupling. In this case the problem noted above is minimized if not deleted.

Pictorial outlines of the two basic types of "rigid" and "semirigid" coupler systems are shown in Figures 4-3 and 4-4.

1) Increased Gathering Range: Both the flat-face and spread-claw type of couplers present opportunities for a much greater gathering range than is possible with the present Type "E" coupler head.

The spread-claw design utilizes wide diagonal gathering faces which force the opposing coupler into both vertical and lateral alignment. The greatest basic gathering range was for Concept 309, which had a 17.4 inch lateral, 11.0 inch vertical gathering range (which is approximately 4 times the standard ranges). Next in order of decreasing gathering range were Concepts 457 and 301b.

The flat-face design depends upon a protruding horn (or hook) being guided into an opposite recessed funnel to achieve lateral and vertical gathering. This gathering, although larger than the Type "E" system, is limited by the cross-section of the horn. The two largest gathering ranges were exhibited by Concepts 6a and 9 which were approximately 2.5 times the standard ranges.

Some designs utilized protruding external guide arms or guide pins in order to facilitate a greater gathering range. It was determined that this concept, although quite workable in low force situations such as rapid transit applications, does not have the design strength and ruggedness required for the relatively uncontrolled rail freight service. In some designs the coupler would experience a blocking in which the guard arms would interlock to prevent coupling. These concepts were set aside for consideration in the candidate coupling systems.

2) Positive Locking: It is desirable that the mating units come into complete locked coupling solely as a result of the mechanical coupling forces. It is also desirable that some means other than gravity be utilized to lock the mated couplers together. It is absolutely required that positive locking be achieved without the requirement for additional air or electrical energy to the coupler head. In addition, it is desirable that the lock be retained even with the subsequent loss of air or electrical power, should this be an added feature.

Of the flat-face type of couplers, Concept 9 exhibited the best locking action with hinged locking hooks, a positive spring

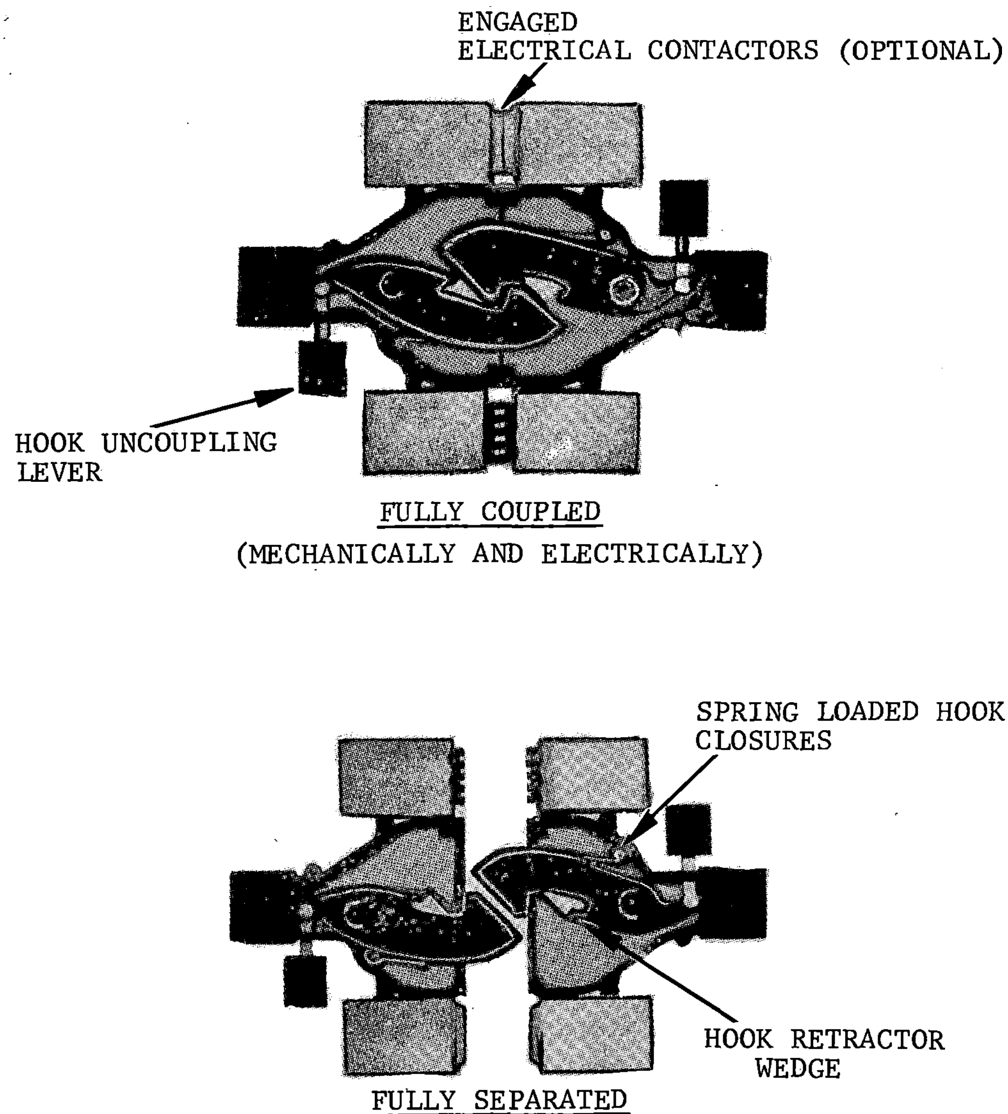


FIGURE 4-3. RIGID, FLAT-FACE, HORN-FUNNEL COUPLER

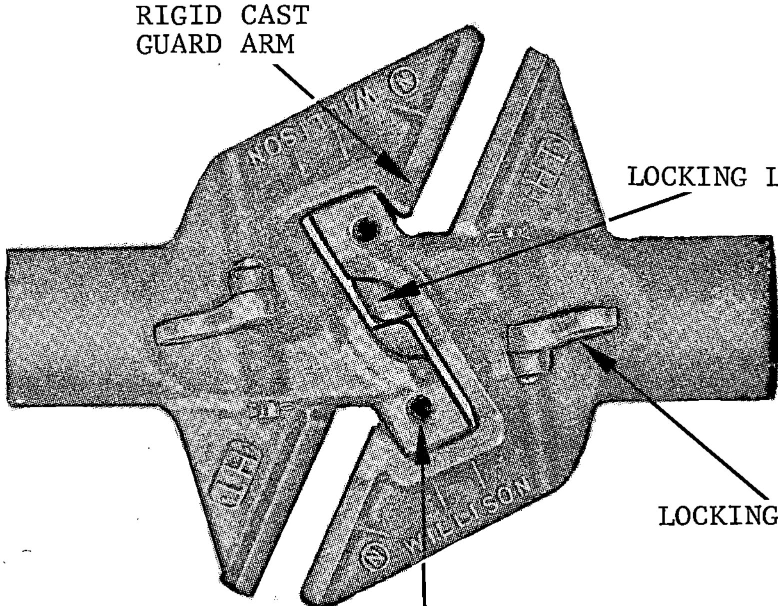


FIGURE 4-4. SEMIRIGID, DISCONTINUOUS MOVEMENT, SPREAD-CLAW COUPLER

loaded interlock, and a direct coupler locking action as a result of compression of guide pins located on the coupler face.

Of the spread-claw type, Concept 309 exhibited the best locking mechanism with a spring-loaded hinged locking hook. In addition, Concept 309 exhibited a cost-effective locking mechanism design composed of six unmachined steel castings assembled with one locking spring.

3) Reduced Free Slack: The flat-face type of coupler unit generally exhibited the least amount of free slack. This was the result of the design concept requiring a flat machined face as the joining surface between mated couplers. The one exception to this (Concept 6a) utilized a cast front face with minimal machining while still achieving a minimum free slack of 0.125 inch. There is not general agreement concerning the potential problems resulting from damage to the edges of the front machine faces on this type of coupler. It is recognized, however, that there is a potential for damage to these machined edges and/or warpage of the front machine face, which could cause a decided increase in free slack and potential problems with completion of the coupler locking.

With the spread-claw type of couplers, only one unit exhibited a very small amount of free slack. This unit (Concept 33) depends upon an extensive amount of machining to achieve this low free slack and represents a rather complicated coupler system, which would not be cost effective. The free slack of 0.31 inch exhibited by Concept 309 represents the typical free slack available with a cast forged head design of this type of coupler. Concept 36 exhibited a wedge type takeup device used in the locking mechanism which resulted in reducing excess slack as the couplers came into a locked position. This design concept should be considered for later potential; however, its use has been restricted to a very light-duty rapid transit system.

4) Vertical Interlock and Entrapment: Several acceptable concepts were noted to achieve coupler interlock, to prevent vertical movement after coupling and to trap a mated broken coupler. The primary locking mechanism for all "rigid" types of couplers is the movement of the locking horn into a funnel or recess in the mating coupler. After the couplers have been securely locked, the overlapping of the adjacent hinged locking hooks accomplishes the desired interlocking.

In the flat face type of coupler, other interlocking devices used included a guide pin/dowel interlock (Concept 9) and cast overlapping external flanges (Concept 6a).

In the spread-claw type of coupler, the basic additional interlock (in addition to the hinged locking hook) is accomplished by the tongue and groove effect of the interlocking spread claws. This concept is typified by Concept 309 or 301a.

5) Summary: Although no one system embodies all of the desired features, two coupling systems stand out as having the best overall combination of these features. These are: Concept 309 in the spread-claw type design and Concept 9 in the flat-face design.

4.2.2.2 Compatible With "E" System

As noted in Section 3 above, there has been a scarcity of new development efforts applied in the U.S. over the last several years for new rail freight coupling systems. It is therefore not surprising that the concepts which were compatible with the "E" system related exclusively to modifications of the "E," "F," or "H" coupler systems which had been in service for several years in either freight or passenger service. The improvements in total coupler systems are therefore much more modest in these compatible units than is the case with the noncompatible units above.

1) Increased Gathering Range: The lateral gathering range for a type "E" coupler is 2 inches with one knuckle open and 4 inches with both mating coupler knuckles open. Of all the concepts relating to increased gathering range, only one type of concept was applicable to couplers which mate with the "E" type system. This concept is the increased gathering range due to a change in the coupler knuckle contour. The technical relationship of knuckle contour to overall gathering range is as follows:

In the "E" type of coupling system, the lateral gathering range is a function of two basic components: (1) one or both knuckles being open, and (2) the amount of engaging force exerted by the open knuckle as it comes against the face of the opposing closed knuckle or guard arm forward contour.

The final alignment of the couplers is the result of the forces exerted at the knuckle faces during the initial and subsequent sliding contacts. The lateral forces supplied by this sliding contact must be sufficient to overcome the friction required to move the entire coupler head and shank into alignment while, at the same time, allowing a sliding of the knuckle faces without causing the knuckle of the open coupler to close prematurely before it passes beyond the tip of the opposing coupler nose and into the closure pocket. Should the open knuckle close prematurely, the resulting closed knuckle cannot enter into a coupled engagement of the opposing coupler is simultaneously in the knuckle-closed condition.

The coupler knuckle contour changes are intended to reshape the forward and outer surfaces of both the coupler knuckle and guard arm faces such that the contours will come into direct sliding contact. The desired contours would force the opposing components to be in sliding lateral motion along the entire length of contact. The closing forces would thus be incapable of forcing the knuckle to rotate from the open to the closed position until the tip of the knuckle had passed the tip of the mating coupler. The net result is an increase in total gathering range.

Concepts 501 and 502a both concern a coupler knuckle contour change. Concept 501 achieves the greater increase in lateral gathering range to a total of 6.875 inches, which is 1.7 times the standard total gathering range for the Type "E" system of 4 inches (assuming that both knuckles are open).

In the area of increased vertical gathering range, the only concept giving an absolute increase in range was the use of the Type "F" coupler as given in Concept 428b. This type of coupler head increases the vertical gathering range from the AAR Interchange Standard requirements of 3 to 4.5 inches. It should be noted that the "E" type of coupler head has no restrictions for vertical movement and, in fact, will allow maximum vertical movement of approximately 7.25 inches before the mated couplers drop out of connection. There is actually a potential for a coupling of a "E" type of coupler head above the standard 3 inches vertical gathering height up to the 7.25 inches knuckle vertical height at which point there is a bypass rather than a completed coupling. Therefore, the use of "F" type of coupler head guarantees a capability of 4.5 inches in vertical gathering height, but may in fact represent a lesser vertical coupling gathering range than can be accomplished with the unrestricted "E" coupler system.

Concept 702 describes a technique for adding guard-arm extension faces at the top and bottom on an "E" double-shelf coupler in order to achieve an increase in vertical gathering range. Such extensions, however, are viewed with caution, since they must have considerable strength and rigidity in order to withstand the normal coupling forces. For example, there were problems reported from railroad users concerning the damage or complete breakage of the side-extending interlocking lug or pocket, which is a design feature of the Type "F" coupler head system. (See Figure 4-5 for an example of the Type "F" coupler head geometry.) Concept 702 is therefore included as a significant concept; however, field testing may indicate strength difficiencies in this concept.

2) Positive Locking: No concepts of significance uncovered in the literature and patent search gave a positive locking technique for the "E" type of coupler system similar to the locking mechanisms available for the noncompatible "rigid" type of system noted in Section 4.2.2.1. The only significant concept which approached a positive locking feature was Concept 502b. This concept has been developed and field tested and has been proven to be fully interchangeable (or "compatible") with the standard Type "E" or "F" couplers. The operating characteristics are:

A spring loaded mechanism maintains the knuckle in the open position when the coupler is uncoupled. The knuckle disengagment plunger is forced rearward by the knuckle of the mating coupler and thus disengages the automatic spring loaded knuckle opening

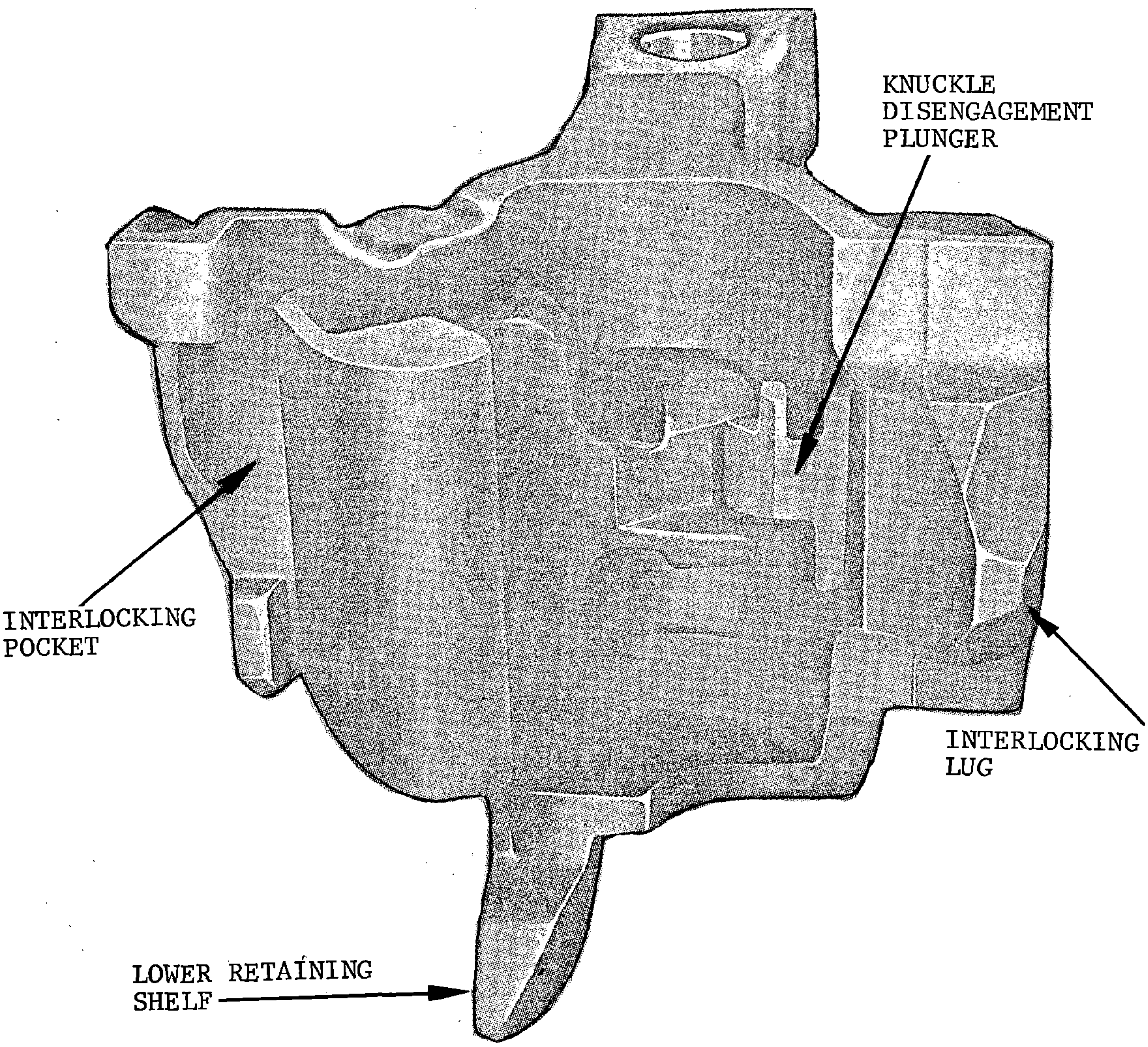


FIGURE 4-5. AAR TYPE "F" COUPLER WITH "KNUCKLE OPEN" MODIFICATION (CONCEPT 502b)

feature permitting the coupler to close and operate normally. The positive forceful disengagement of the knuckle locking spring results in a positive release of the knuckle locking mechanism allowing it to drop into place under gravitational force.

This does result in a more positive locking of the closed knuckle than is the case with the standard "E" coupler head. Figure 4-5 pictures Concept 502b as applied to a Type "F" interlocking coupler head.

3) Reduced Free Slack: Two different AAR coupler designs currently in field use have a reduced free slack as compared to the Type "E" system. These are: The AAR Type "F" (Concept 428b), which has a free slack of 0.37 inch, and the AAR Type "H" (Concept 428a), which has a free slack of 0.25 inch. These compare to the basic Type "E" system free slack of 0.78 inch. The only other significant concept which has the potential for reducing free slack is Concept 501. In this concept, a coupler knuckle contour change was developed in conjunction with the addition of fronting material on the face of the knuckle to add approximately 0.078 inch to the front of the Type "E" knuckle. Concept 501 therefore results in a free slack of 0.62 inch for two mated Type "E" couplers or approximately 0.3 inch for two mated Type "F" couplers.

The Type "H" coupler head described in Concept 428a requires extensive machining in order to achieve the minimum free slack. This coupler was developed for use with passenger cars and has potential problems of inadequate strength if applied to freight car service. It is thus summarized that the most logical concept for improvement in free slack would be the utilization of the Type "F" system of Concept 428b used in conjunction with the modified knuckle contour and front face buildup as exhibited in

Concept 501.

4) Vertical Interlock And Entrapment: The AAR Type "F" interlocking coupler (Concept 428b) was designed to achieve an interlocking of mated couplers to prevent the drop-off of a broken coupler in a derailment situation. This interlocking coupler design is currently used on tank cars or long cars or those designated for dangerous application. This coupler system, however, provides a full interlock only when mated with another Type "F" coupler. When mated with a Type "E" unit, the Type "F" coupler will allow the mating coupler to ride over the top and become disengaged should derailment or other forces cause the vertical movement of the Type "E" coupler.

Two concepts have been developed to correct this "ride-over" possibility: Concept 52 which applies a top shelf to the Type "F" coupler, and Concept 54, in which a top and bottom shelf is added to the standard Type "E" coupler. These and other related references report that both concepts will achieve a vertical interlock and entrapment of a broken mated coupler. Concept 702 applies to Concept 54, the added concept of an additional guard-arm extension at the top and bottom shelf faces of the double shelf Type "E" coupler to achieve a purported increase in lateral and vertical gathering range in addition to achieving the interlocking features.

It is recognized that the Type "F" coupler of Concepts 428b and 52, although having less free slack and interlocking features, is still not sufficiently rigid so as to allow integral air and electrical connections. In addition, the physical space available within the confines of the coupler head (See Figure 4-5) shows that there is no space for such internal attachments. If add-on or external air and electrical connectors are to be considered, the AAR Type "F" coupler is more feasible than the Type "E" with top and bottom shelf (Concept 54), since the Type "F" utilizes less vertical space underneath the center line of the coupler head and has less free slack. However, one universal air connector is preferable to two separate designs for reduction of both initial and maintenance costs. Therefore, an air connector designed to handle the gathering and free slack of the "E" coupler system should be chosen, since it will automatically encompass the "F" system requirements.

5) Summary: Two potential coupler systems emerge from this analysis of the compatible coupling concepts. Listed below are the concepts included in Type "F" and "E" coupler systems.

(a) A system based on the Type "F" coupler head (Concept 428b) has the following modifications.

1. Addition of a top shelf (Concept 52).

2. Increased gathering range and reduced free slack by change to knuckle face (Concept 501).

3. Positive knuckle locking and knuckle open provision (Concept 502b)

(b) A system based on the use of the standard Type "E" coupler head system includes the following modifications.

1. Addition of a top and bottom shelf (Concept 501).

2. Increased gathering range and reduced free slack by change to knuckle face (Concept 501).

3. Increased gathering by the addition of guard-arms (Concept 702).

4. Positive knuckle locking and knuckle open provision (Concept 502b)

4.2.2.3 Coupler Location Control

The reasons for needing coupler location control devices are related to the instability of long cars on curves. Instability on curves results from a high lateral component of coupler force which is brought about by high shank angles between adjacent couplers. Possible solutions to this problem are:

1) Reduce car length and overhang
2) Increase the light car weight
3) Lengthen the coupler to reduce the shank angle.

Car length and light car weight are dictated by economics which have been previously established. Car length overhang is dictated by the length of the car and the required radius which the car must traverse. Thus, the only practical solution is to lengthen the coupler.

The lengthening of the coupler increases the problem of "jackknifing" between mated couplers. The best practical means of avoiding such jackknifing is to use an interlocking coupler head. Such interlocking decreases the amount of play between adjacent coupler heads and therefore requires a vertical pivoting of the shank to permit the required vertical movement between the coupled heads. The long-shank couplers must also be mounted such that they pivot in their yokes to permit cars to operate on standard radius curves. Unless they are kept centered by some means, such long car couplers tend to become misaligned after being uncoupled as the result of lateral forces (such as involved in switching wherein the car transverses a sharp curve).

It should also be noted that during operating conditions encountered by loaded trains, fast or emergency braking of the train can result in an eccentric loading of the coupler such that the connected couplers have a tendency to swing laterally with resultant outward forces tending toward derailment of the coupled cars.

Therefore, to be effective from both an operational and safety viewpoint, coupler locating devices are desirable on long cars. Moreover, to achieve maximum operating safety under emergency stop conditions, such devices should have a tendency to maintain a centering of the coupler shank in both the coupled and uncoupled condition. To have the greatest effectiveness, it is desirable that the centering device apply a greater force directed toward centering the shank when the car is under extreme buff conditions such as is encountered during emergency braking operations.

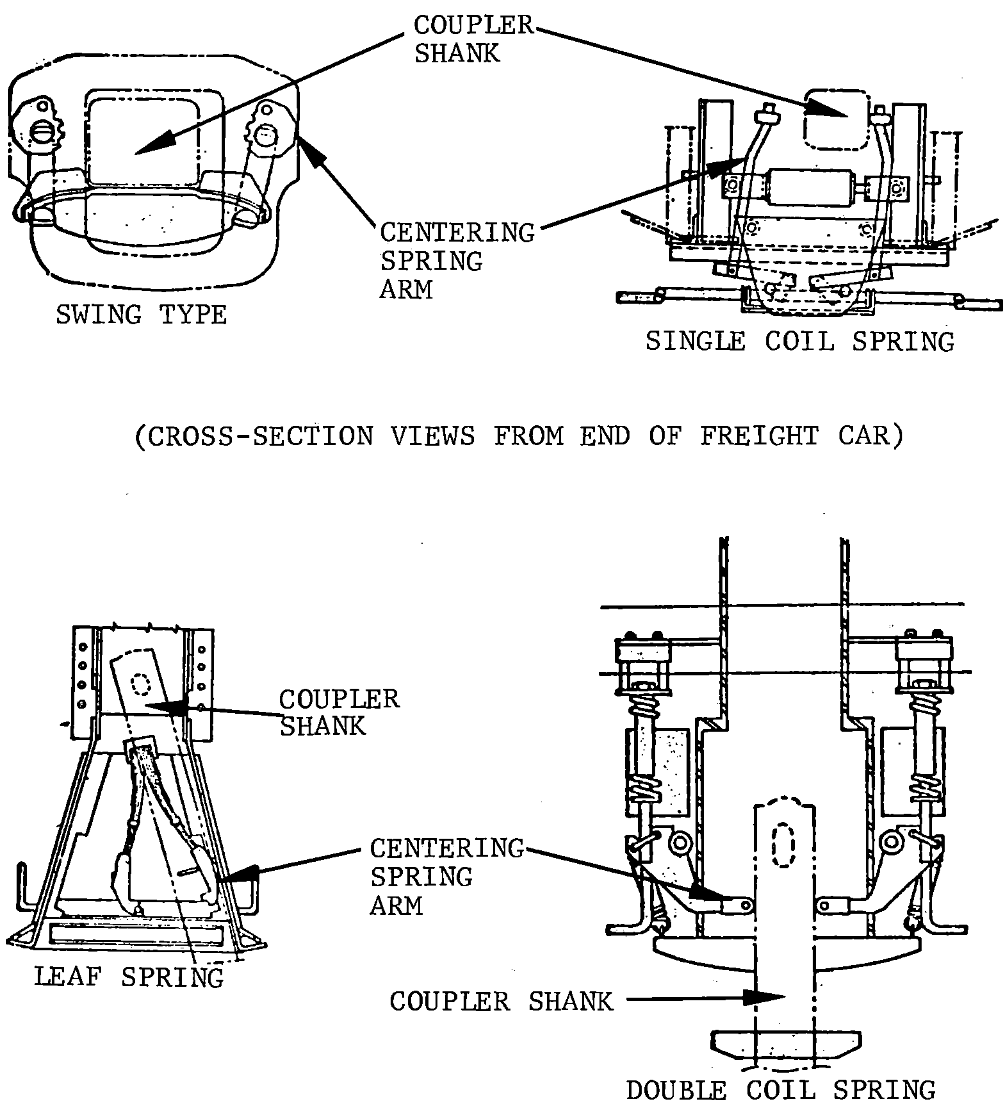
1) Types Of Location Control Devices: Concepts for two types of location control systems have been reviewed: centering and positioning devices. A coupler centering device (See Figure 4-6) assures that the coupler is centered with respect to the centerline of the track when on straight tangent track or on a slight curve. It is the concensus of the technical material reviewed that centering devices would remedy approximately 50 percent of all operating bypasses occuring on short cars (assuming the use of Type "E" couplers). On the other hand, centering devices would not be particularly effective for long cars (because of the long effective coupler length and overhang of the end of the car from the truck centers), except to the extent that they would keep the long-shank couplers from sliding to one side during uncoupled yard switching movements.

A coupler positioning device (See Figure 4-7) assures that the coupler head is centered toward the centerline of the track. The positioning device senses the change of angularity between the car trucks and the centerline of the car body upon which the coupler mounting sill is attached) and guides the coupler head through an interconnecting device. As the car traverses a curve, the trucks follow the track and change the relative angle with the centerline of the car. This change in angle is then transmitted through a mechanical and/or hydraulic linkage to position the coupler head in the direction that the trucks are turning, thus tending to keep the coupler head in alignment ready for the next coupling operation. Although practical positioning devices cannot assure absolute track centering of the coupler head on long cars, they can function to bring the coupler head within expanded gathering ranges possible with Type "E" and Type "F" coupler heads.

Coupler centering devices are in widespread use in rapid transit applications and, to a lesser extent, in railroad freight service. Coupler positioning devices are only in very limited use because of their high initial cost and experience with damage and maintenance problems in actual usage.

It is the concensus of technical reports that effectively designed positioning devices would eliminate from 80 to 90 percent of all bypasses occurring with long cars and approximately 95 percent of all bypasses with short cars. This concensus assumes the continuation of the same gathering capabilities as is currently available with the Type "E" coupler head in use on short cars and the Type "F" coupler head generally in use on long cars. No data were reviewed which related quantitative information showing the bypass probability when only one car of the coupled pair had a positioning device installed.

2) Undesirable Features: More than 25 different significant concepts were reviewed which related to centering and positioning devices. Most of these devices were shown to have



(VIEWS FROM TOP OF CAR)

FIGURE 4-6. "TYPICAL" COUPLER CENTERING DEVICES

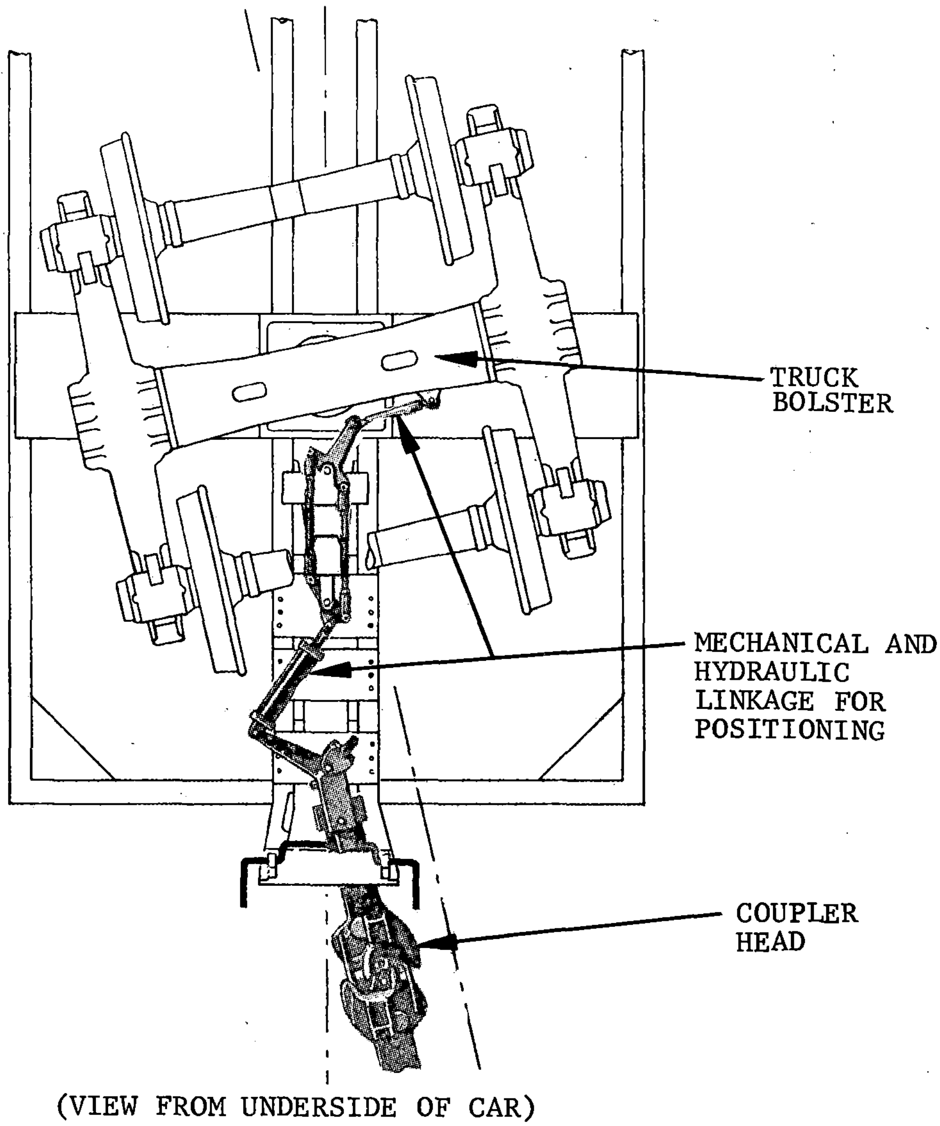


FIGURE 4-7. "TYPICAL" COUPLER POSITIONING DEVICES

a tendency to malfunction mechanically or to be subject to excessive damage and maintenance problems in the field. These undesirable design features include:

(a) Complicated compound control linkages (field damage and replacement problems were universally associated with complicated linkage systems).

(b) Chain and cable linkage (potential problems for harmonic vibration and shock damage are inherent where light gauge chains or cables are used).

(c) Unprotected hydraulic cylinders (subject to excessive road damage and leakage).

(d) Passive air cylinders (introduce an element of system unreliability unless the air cylinders are well protected or are subject to frequent maintenance inspection for leakage).

(e) Air-inflated rubber boots (subject to environmental embrittlement and loss of centering capability).

(f) Use of rubber as the sole centering force (subject to loss of return force capabilities as a function of fatigue and environmental deterioration).

(g) Design with high leverage moments (potential for loss of control capability as expected environmental grime accumulates in the control mechanism).

(h) Light duty structural design (subject to low reliability and high maintenance due to expected wear, shock, and vibration damage).

(i) Manual disengagement under load. (During the expected coupler transition period, there will be cars which are unequipped with any centering devices which will result in the need to position the coupler head of the unequipped car manually. If the centering or positioning device does not have a force-free center location, it becomes physically difficult if not impossible for one man to disengage the location control device and position it to the center.)

3) Centering Devices: A review of the technical concepts of the various centering devices resulted in most being set aside as truly significant on the basis of shortcomings for one or more of the problem areas defined in the undesirable features section noted above. Of the remaining concepts, three types stand out as meriting potential application. These are:

(a) Self-centering with the draft gear systems. Concept 26 uses the draft gear compression force to center the shank with the centerline of the car at any angularity greater than 4 degrees. Concept 1190 uses the buffing force of the draft gear return spring to apply a bias force against lateral extended bearing surfaces on the shank butt to achieve a self-centering beyond a designed "free force" center range of approximately 4 degrees.

The 4 degree offset would tend to center a short coupler within 2 inches of the center line and within 4.2 inches for a long car. Technical literature suggests that angularity above plus or minus 4 degrees would be expected from 10 to 20 percent of the operating time.

(b) Centering aided with side springs. Concept 318 includes a concept in which the springs apply recentering force at lateral movements greater than 1.2 inches off the centerline. This concept would achieve a greater centering capability than self-centering by reason of the external spring force while maintaining the potential for easy manual release of the centering device should it be required for coupling with unequipped cars.

(c) Centering with external force wherein the centering system is automatically engaged from an external remote signal.

Concept 503a defines an air cyclinder system which is automatically engaged or disengaged through a train line automatic control system. This concept is technically feasible if there is an inter-car control system, since it utilizes the readily available air line pressure for the energy to be applied to the centering cylinders. To protect against road damage, it is assumed that the operating plungers and the air cylinders would be housed within a closed area extending on both sides of the bell housing underneath the car sill.

4) Positioning Devices: The only positioning device which appears to meet the needs of the general requirements as stated above is Concept 31b. This is a simple system primarily composed of two hydraulic cylinders which operate from the relative truck/ car movements to move directly the coupler shank. The cylinder plungers are protected and have short strokes which would minimize possible scoring damage from external blows. The system offers the potential for easy mechanical disengagement to allow for manual centering. It is realized that this system would primarily be used for a long coupler unit, which would be quite heavy and thus difficult to move by hand after the positioning device was disengaged. It must likewise be recognized that all positioning devices are sufficiently complicated that they should be subject to required periodic maintenance and inspection.

5) Reduced Contour Angling: As noted in the general requirements above, long cars require the use of long shank couplers, which in turn dictate the need for interlocking coupler heads. The net effect is a decrease in the required swing angle of the coupler shank and therefore a reduced contour angling.

Accordingly, a secondary benefit in the use of any of the interlocking coupler designs noted in 4.2.2.1 or 4.2.2.2, will be reduced contour angling.

The centering device of Concept 1190 has a definite application for reducing contour angling possibilities and potential for derailments. In this concept, the unit imposes a centering force on the coupler shank with increasing magnitude as the buff forces are increased on the coupler (such as in emergency braking situations).

The draft gear impact-absorbing device includes a center return draft spring which acts through a yoke onto the coupler shank. The draft gear yoke and the coupler shank butt have spherical bearing surfaces on either side. During lateral movement of the coupler, the shank leaves the sperical bearing surfaces and abutts on one of the side extending portions in the yoke. This results in the force of the return spring in the draft gear being exerted on one side of the coupler shank, thus there is a centering force applied to the shank. A greater thrust against the return spring (as involved in greater buffing forces) results in a greater centering force being applied to the outer lip of the shank butt. The result is a reduced contour angling and a reduced lateral force vector, which lowers the probability for a derailment.

4.2.2.4 Reduced Maintenance

Each of the design concepts relating to reducing free slack or interlocking coupler heads has a secondary benefit of reducing coupler maintenance because of a reduction in wear on the coupler head. In addition, the standard manganese-steel wear plates, which are universally used at heavy friction wear points, result in reduced long-term maintenance.

The only concept which specifically addressed itself to reduced maintenance was the use of lubrication fittings as defined in Concept 503a. This is not a new engineering concept, but it represents the type of small initial cost in a coupler system which can result in extensive reduction in long-range maintenance costs. Even though the lubrication fittings may not be used in a scheduled periodic maintenance program, the use of this design concept should be applied universally at heavy wear points in coupler systems to help reduce component wear.

The use of other materials for the standard wear plates has not been included as a new concept, since the manufacturers who supply wear plate materials are continually in a program of upgrading the value of these wear plates by increasing their wear and self-lubrication properties.

4.2.3 Mechanical Upcoupling (Category III)

Mechanical uncoupling system design capabilities are limited by the overall coupler design. Thus, the concepts for mechanical uncoupling are logically defined by the two design types ("free" and "rigid") of construction as outlined in Section 4.2.2. The analysis of the various uncoupling concepts was therefore grouped similar to Section 4.2.2 for those which were noncompatible with the "E" system and those which are compatible with the current basic system.

Once characterized in terms of compatability, each concept was reviewed for impact upon functional characteristics involving improvement of uncoupling or recoupling capability. In addition to examination of specific functional characteristics, emphasis was placed upon analysis of each concept concerning its potential to operate satisfactorily under the expected environmental extremes, particularly with respect to contamination and mechanical damage.

4.2.3.1 Noncompatible with "E" System

The Concepts falling into this category are generally applicable to the "rigid" type of coupling systems, which include the flat-face and spread-claw types. Some of the control systems to be discussed in the subsection "Automatic Uncoupling Release From Within Train" are potentially applicable as control mechanisms for compatible systems. This possibility will be discussed, however, in the general systems discussion of Section 4.2.4.

1) Alternate Side Lever Uncoupling: Only two systems offered concepts including the addition of an alternate mechanical side lever to initiate uncoupling. These were Concepts 301a and 309. This concept allows the potential for initiating the mechanical uncoupling from either side of the car, which would be a particular advantage for switching in flat yard operations. The concepts included a second uncoupling lever attached to the coupler head with a cable connection or a rigid joint-and-shaft system, with the latter system as shown in Concepts 309 being the more preferable as being a mirror image of the proven uncoupling system.

2) Side of Car (Push-Button) Uncoupling: For increased switchman safety, it is desirable that mechanical uncoupling could be initated at a point outboard from the outside surface of the car. This could be accomplished by either a mechanical linkage or other remote connection device.

Concept 309 included the concept of an uncoupling release by operating an air valve located at the extreme outside of the car. Similarly, Concept 511a included initiation of uncoupling by operating the pneumatic uncoupling system from an air valve at the side of the car. In the electropneumatic control system, Concept 254, there is an option for an electrical switch at the car exterior which would initiate uncoupling through the electropneumatic control system. Each of these concepts appears to offer an equal potential for side-of-car uncoupling; both Concepts 309 and 511a are dependent only upon an air system, while Concept 254 requires both an air and electrical control system.

3) Automatic Uncoupling Release From Within Train: Several concepts were evaluated which had a capability for initiating the uncoupling sequence by an external source. For the most part, these involved the uncoupling release from within the car being uncoupled (as required for rapid transit applications). Four different techniques of control were used. A listing of these techniques and the concept references follows:

(a) Electropneumatic system - in which the signal is generated electrically and then followed by the uncoupling force being generated from a pneumatic force cylinder. Concepts 9, 27, 33, 36, 254, and 503a are significant. The only problems noted with any of these systems was that related to excessive force required to operate the uncoupling mechanism such as is the case of Concept 33. The other systems are best characterized by Concept 254 which embodies features included in other concepts.

(b) Pneumatic switch control - in which uncoupling is initiated through an air pressure signal transmitted remote from the coupler area. This concept was included in Concepts 301b, 309, 391, and 511a. Each of these systems was limited, however, to the uncoupling signal coming from the adjacent car and is not considered generally adaptable to a long train situation pending some sort of inter-car connection including a logic and control system. The best of these systems is characterized by Concept 309. The vacuum brake release system concept of Concept 45b could be considered for this type of uncoupling control, however, it is considered to have greater control difficulties and would likewise need a separate logic and control system.

(c) Electric switching - in which the external control signal is transmitted electrically to the coupler head with the uncoupling lever actuated by an electrical solenoid or linear actuator. This concept was embodied in Concept 301b and 450a. A review of user reports indicates a continuing problem with direct electrical solenoid operation of the uncoupling mechanism. Environmental contamination can cause a binding of the uncoupling mechanism and, if the coupler is in any force state other than free slack, there is possibility of binding due to buff or draft forces. None of the coupling concepts which were reviewed offered a solution to these potential binding problems. Therefore, the direct electrical operation of uncoupling mechanisms through electrical solenoid or linear electrical actuators is not recommended.

4) Automatic Uncoupling Release From A Point External To Train: Among the several concepts reviewed were systems for an external mechanism to operate the standard uncoupling lever. These included, for example, a rotating brush system which would force up the uncoupling lever as the brush system rotated between the cars to be uncoupled. A second system for performing the same operation was an electric eye which would detect the opening between cars and actuate an arm system which would mechanically raise the uncoupling lever. These and other totally external systems were not evaluated as being significant, since they applied to a system which was totally external to the train.

The only concept directly applicable for an external control system was Concept 450b, a microwave transmission control system. This is a viable concept for control, assuming that each car has its own logic system, and its own power generation system, or that there is an intercar electrical power connection and appropriate electric or pneumatic uncoupling devices are included in each car uncoupling system.

Concepts relating to an external electromagnetic uncoupling signal were not included as significant, since these depended upon the need of a electromagnetic coupling between cars (such as Concept 1150), which is not accepted as being a viable concept because of the extremely high force and electromagnetic currents which would be required in order to maintain the coupling of all road operating conditions.

5) Uncoupling in Draft: A basic design feature of all coupler systems reviewed was that they are designed to have increasing resistance to uncoupling as the draft loads increase. This results in an increasing bind on the unlocking components as the draft load increases, which has the tendency to prevent accidental uncoupling as the locking mechanism components become worn. This is considered to be a desirable feature as it relates to safety of operation.

Two types of unlocking mechanisms were demonstrated. Hooks forced apart by sliding rod or wedge action (such as Concepts 33, 47a, and 511a), and hooks forced apart by a rotating cam action (such as Concepts 9, 27, 301a, 391, 457, 503a). The sliding wedge or rod unlocking systems all evidenced binding and force problems with minimal draft forces. The rotating cam unlocking concepts indicated unlocking forces of about 100 (Concept 301a) to 1,000 pounds (Concept 503a) and up to a maximum of 8,800 pounds

(Concept 391) by use of a pneumatic force booster.

In summary, the concept of uncoupling in draft is not considered to be a viable concept except when it involves nominally low draft loads. Even the highest draft load uncoupling capability evidenced in Concept 391 was obtained only with the use of a full 100 psi line pressure acting through an air cylinder. Since switching operations would be enhanced by a capability for uncoupling in draft, a rotating, air-force boosted, unlocking cam (such as in Concept 391) is suggested as the most viable concept.

6) Knuckle (Or Locking Mechanism) Always Open After Uncoupling: Probably the most important feature relating to the reduction of the probability of coupler bypass is the knuckle open feature. In the noncompatible coupler systems, most of the designs included this concept. Two different techniques were utilized: a spring-loaded locking device and a gravity-drop locking device.

Those concepts offering a spring-loaded locking hook, plate or pawl included Concepts 6a, 9, 27, 33, 301b, 391, 448a, 457, 503a, 511a, and 516a. Of these, the better systems were those having a spring-loaded locking hook or pawl, with Concept 309 perhaps exhibiting the typical system in this regard. However, almost all of the other concepts share equally in this capability.

The gravity-drop type of locking system as evidenced in Concept 47a is not considered acceptable for this requirement since the unforced gravity lock drop system is subject to potential jam-up due to accumulation of environmental grime, etc.

7) Mechanism To Prevent Coupling: Two concepts indicated a capability for manual lockout of the coupler locking system in the closed position. Concept 309 contained a provision to lock open the locking pawl manually to prevent automatic recoupling upon subsequent coupler contact. Concept 457 contained a provision whereby the uncoupling lever could be locked in the position holding the locking hooks open. The provision offered by these concepts seems desirable as an aid to yard switching operations by preventing the automatic recoupling of cars for temporary car movement operations.

8) Summary: The coupler system Concept 309 has been previously identified as having the best overall features in the Category II of mechanical coupling. This system also exhibits the greatest potential for including the desirable characteristics of mechanical uncoupling. An additional desirable feature would be the addition of the rotating cam uncoupling concept as noted in Concept 391, which would increase the potential for uncoupling in draft. Where a full train-control system is desired, Concept 254 offers the greatest potential for accomplishment of automatic uncoupling from the side of the car or elsewhere within the train. If automatic uncoupling release is desired from a source external to the train, the only viable concept is Concept 450b.

4.2.3.2 Compatible With "E" System

As previously indicated, there were considerably fewer concepts applicable to changes compatible with the "E" type coupler system. These did, however, address themselves to some of the more pressing problems in the present coupler system.

1) Alternate Side Lever Uncoupling: The Type "H" tight

lock coupler system (Concept 428a) offers an optional double lock lift assembly which allows for the use of a second side uncoupling lever. Concept 502b includes the provision for a rotary bottom lock set unit, which likewise allows for the use of a second side uncoupling lever. Both of these are viable concepts and have been in use in passenger car and locomotive applications.

2) Remote Uncoupling: Two types of remote uncoupling systems were reviewed, each relating to the operation of the Type "E" system uncoupling lever by use of a remotely controlled device involving the use of hydraulic or electrical forces.

Concepts 1046 and 943 refer to a hydraulically operated mechanism which directly operates the uncoupling linkage in the standard Type "E" coupler system. Since this type of uncoupling mechanism has been successfully demonstrated for the noncompatible systems (Concepts 309, 391), this approach has definite potential assuming that it is associated with an acceptable control system.

Concepts 502c and 1045 rely on operation of the uncoupling levers directly from the force of an electric solenoid. This approach is not accepted as totally feasible because of the problems of excessive power load which can possibly be required to "break loose" the uncoupling rod and mechanism when they are in a bind or locked into position from environmental factors.

Side of car pushbutton operation of the uncoupling lever could be accomplished by use of Concept 674 in which remote actuation of an air valve is made possible through the use of a flexible cable system. This concept would be used in conjunction with the hydraulic uncoupling mechanism operation of Concept 943.

For control of unlocking mechanisms from within the train, Concept 254 offers the best potential for having a combination of electropneumatic control of the various uncoupling mechanisms.

Where uncoupling is to be initiated external to the train, Concept 450b, the microwave transmission system, offers the greatest promise. In either case the use of these remote control systems would require inter-car connections and a logic and control system.

3) Uncoupling In Draft: None of the concepts reviewed were considered to be either viable or significant in terms of accomplishing uncoupling in draft for the "E" type coupler system.

4) Knuckle Always Open After Uncoupling: Only Concept 502b was considered to be viable and significant in terms of an automatic knuckle open condition at uncoupling. In this concept, the knuckle is held in the open position after uncoupling by the force of a spring-loaded lever. The spring force maintains the knuckle open to prevent accidental vibration or shock closure during switching operations. The spring loading can be removed only by the mechanical force of a mating coupler as it comes into final coupling engagement.

5) Summary: Concept 502b incorporates the knuckle open capability and provides the design potential for use of an alternate side lever. For remote uncoupling capabilities, a hydraulic or pneumatic operating lever of Concept 943 can be utilized in conjunction with the cable remote actuator, Concept 674, or with the external control mechanism Concept 254. If remote actuation control is desired, Concept 450b offers potential for control external to the train.

4.2.4 General Systems (Category IV)

The various system control concepts which were reviewed were generally applicable only to noncompatible "rigid" type coupling systems or to compatible add-on systems. This was particularly true of brake control and electric train line systems. The train sensing and control systems, however, are related to the general logic and control functions, which are basically accomplished separate from the coupler. These latter concepts were therefore grouped together as being equally applicable to all types of coupling systems.

4.2.4.1 Brake Control System

1) Noncompatible Integral Systems: These concepts are closely related to those listed in Sections 4.2.1.3 and 4.2.1.4 above in that brake control is interrelated with operation of the airline valves. Two system concepts were evaluated, namely: direct electrical brake control and electrical signal control to operate braking from pneumatic means. Electrical braking of freight cars (as in Concept 450a) is not considered practical because of the extreme braking energy which is required and the associated electrical power demands both at the car and in car interconnections.

Electropneumatic brake control concepts were exhibited in Concepts 9, 27, 254, and 503a. Concept 254 is assessed as having the most complete overall brake control system and with the most potential for a reliable system.

2) Compatible Add-On System: Concept 45b included a system for centrally operating brake release on all cars by way of a second airline system. Pulses of 2 psi vacuum would be made

to operate quick release valves located on each car. Such a system would be applicable to bleed all cars simultaneously in preparation for hump switching. Considering the cost, operational, and safety problems involved with a second complete airline system capable of transmitting vacuum as compared to the minimal benefits of simultaneous car bleeding for hump switching, this concept is not considered sufficiently realistic for consideration. In addition there is good reason to question the capability of maintaining a nominal vacuum throughout the interconnection system involved in a long train.

Concept 22 includes provisions for maintaining the car pressure and therefore leaving brakes unset under intentional uncoupling conditions (operation of uncoupling lever initiates the valve action) and automatically sets the brakes under unintentional uncoupling conditions.

4.2.4.2 Electrical Train Line Systems Of Noncompatible Integral Types

The concepts relating to electrical train line systems generally divide themselves among the spread-claw type of "semirigid" coupler systems where few electrical circuits were utilized and for the flat-face "rigid" coupler systems where large numbers of electrical circuits were required.

1) Automatic Connection: The concepts relating to automatic connection devices were divided into connection systems located on the top, sides, bottom, or within the face of the "rigid" coupler system.

As indicated in subsection 4.2.1.1 in the discussion of air connector systems, the attachment of electrical or air systems above the primary coupler face is not considered an acceptable concept. This approach (Concept 301b) involves the use of space, which has too great a potential for damage from loading and operations.

Electrical connector systems located on either side of the flat faced "rigid" coupler included Concepts 254, 301b, 450a, and 511a.

Those concepts utilizing a connector system suspended below the flat coupler face included Concepts 9, 27, 391, 503d, and 511a.

Both the side-supported and lower-suspended electrical connection systems offer the potential for large numbers of contacts to be included in the electrical system. The potential advantages of support rigidity, contact protection, and insulation are considered equal for these two approaches. The primary disadvantage to the lower-suspended electrical connection system is that it is subjected to a slightly greater degree of environmental contamination, particularly with respect to water and ice thrown up from the road bed during normal operations. In several technical reports, there was reference to ice and rusting problems in the lower-suspended electrical boxes.

The side-supported electrical boxes, although in a better position with respect to environmental contamination, are subject to greater potential for bypass damage. In addition, the side-supported units have a greater problem in maintaining adequate protection of these electrical boxes from damage resulting from coupling on curves or with couplers at diverging angles.

The spread-claw type of "semirigid" coupler lends itself to electrical connections being contained within a protected central portion of the coupler. Concepts embodying this principle included 33, 36, 45, and 309. From an environmental protection viewpoint, this concept offers greater potential in the operational environment required in freight rail service.

2) Contact Capacities: Automatic electric connectors have been subject to intensive development effort for use with rapid transit cars. This application required the transmission of significant power levels and the utilization of extensive number of circuits. On the other hand, the rapid transit application did not require capabilities for meeting severe environmental requirements, as in the case of freight rail service.

In addition, rail freight connectors for either air or electricity must withstand a greater amount of coupler motion because of manufacturing tolerances and operational wear. Electrical connectors must tolerate a sliding motion during the coupling operation and continuous vibration and shock motion during rail operations over rough track.

Two types of concepts were evaluated with respect to the technique of making the electrical connection: butt type and pin/socket type connections.

The butt type connection included Concepts 9, 27, 36, 301b, 450a, 503a, 511a, and 516b. The best of these concepts included a spring backup system with a rotating contact technique as used in Concept 450a. This technique requires the contact to rotate about its central axis while it is being forced forward by a loading spring. This offers a distinct potential for overcoming environmental buildup on the butt surface of the contactor by a wiping action while the contactor is making final connection. Silver plated contact tips (Concept 516b) or replaceable silver contact tips are desirable for this type of butt connector.

The pin/socket type of contactor was exhibited in Concept 33, 45c, and 309, all applying to spread-claw type couplers. Problems with burning of contact surfaces while switching under load were noted with Concept 45c. This problem, however, is considered of lesser difficulty than the inherent problem of overcoming the shearing forces on electrical contacts involved in the lateral and vertical movement of mated couplers. Since long-range coupler wearing (and therefore increase in free slack) is not a controllable item, it is believed that the pin/socket concept of electrical contacting is not as feasible for rail freight service as are butt type contacts.

3) Automatic Sequencing Of Contactors: The problem of arcing between electrical contactors was evidenced in several of the technical references. Although some concepts of sequencing electrical contactors reported to make a "quick" engagement of the contacts, it is still concluded that any contact circuit completion under conditions of heavy amperage load will result in arcing or pitting of the contacts and reduced contact life and reliability. Three possible solutions are offered to this problem:

(a) All contact engagement to be made with electrically dead contacts. In such situation, the locomotive control must energize all electrical circuits after coupling and deenergize them prior to uncoupling.

(b) Use of pilot contactors which energize a very low power circuit, which in turn actuates an external contact closing mechanism (such as Concept 503b), which then closes the electrical circuit to the already mated contactors.

(c) The use of low electical power circuits on all electrical contactors to operate solid state type electrical switching devices which in turn energize pneumatic devices which accomplish the high energy functions. (This concept is basically embodied in Concept 516b.) This approach could be used in combination with the pilot contactor concept of (b) above.

Many different techniques have been suggested for automatically sequencing the contactors into position. The significant concepts are grouped as follows:

(a) Contact block engaged by air inflation of a piston or diaphragm (Concepts 9, 27, 254, 301b, and 516b). Of these, the more promising are Concepts 254 and 516b. A most desirable feature for manually extending or retracting the electrical contactor pins is embodied in Concept 516b. This would allow an excellent backup system in case of a malfunction of the basic control or air inflation system.

(b) Contact closure through use of mercury relays (Concept 450a and 503a) is not considered an acceptable approach since the mercury contact system has a potential for extraneous circuit completion or malfunction as a result of vibration and shock forces which are expected in all phases of rail operations.

(c) Mechanical levering of contactor during the coupling sequence (Concept 511a) is considered to have too many potential difficulties because the close interlocking tolerances required from the mating surfaces. In this concept, the electrical contacts are engaged under spring force while the coupler faces are approximately 0.625 inch apart. This increases the depth to which the insulators must engage and magnifies the problem from slight misalignment in the coupling heads which would be corrected during the final 0.625 inch travel.

Good maintenance features were noted in Concept 254 relating to the ease of removal of the contact box after engagement for any maintenance requirements. In the spread-claw type of coupler design contact system, Concept 309 exhibited the best system for removal of the contact system from the rear of mated couplers.

4) Environmental Protection of Connectors: The performance requirement that all coupler systems must be compatible with the expected operating environment is particularly relevant to the design of electric connectors. Contact corrosion problems can be surmounted or controlled by the use of specifically designed component materials (such as silver plating in Concept 516b). Specific environmental conditions which could cause problems with electrical connectors include:

(a) High humidity and water conditions which lead to potentially high corrosion rates created by galvanic corrosion initated by electric potential across the dissimilar materials.

(b) Temperature extremes varying from -50 degrees F to +140 degrees F may be encountered as the freight cars are in use or on storage tracks. This environment can have a particular impact in deterioration of rubber diaphragms or embrittlement of of plastic insulator materials.

(c) Basic surface contamination of dust, dirt, or environmental grime can be expected to build up on the electrical contactor faces and in moving portions of the system.

(d) Extensive vibration and shock is expected on all parts of the system during road operations. In addition, the electrical connector (and air connector if supported below the coupler head) will be subject to impact damage from flying rocks and debris while the train is in motion.

The approach taken in almost all concepts to protect against environmental damage to, or interference with, connector operation has been the use of an environmental protection cover.

The cover apparently gives good environmental protection but universally presents a problem in assuring that the cover is opened up or pushed aside prior to final coupling, in order that the electrical contacts are open. The three different approaches taken to accomplish this cover movement were:

(a) Direct retraction of a lower mounted cover by coupler movement of a guide pin or push bar (Concepts 511a and 516b) are analyzed as having distinct problems for consistent operation. In the case of Concept 511a, the door depressing pin would be subject to damage or deformation from coupling forces involved in wide angle coupling. In Concept 516b, the horizontal push bar would have a high probability of incurring damage from coupling impacts on one edge of the pushbar. Any pushbar or direct acting pin would have to be extremely strong to withstand the lateral forces of coupling while depressing smoothly as required to operate the cover mechanism. In addition, Concept 516b utilized a lower recessed track in which the box cover would slide. This concept would have a high probability of clogging up with grime or ice and thus blocking the path needed for movement of the cover.

(b) A wedging or levering aside of the cover by direct contact from the opposing cover (or a guide arm extending outward on the cover) was exhibited by Concepts 9, 27, 33, 36, 43c, 254, 309, 503a, and 516b). There were numerous reports from users as to difficulties on this type of cover mechanism in which coupling damage occurred to the cover which prevented it operating smoothly enough to be levered aside prior to the final coupling. These reports of coupling damage were particularly prevalent on the side mounted electical connector unit.

(c) Removal of the cover after the mechanical coupling was complete was exhibited by Concepts 301b. In this system, the completion of the mechanical coupling engaged a switching mechanism which released pneumatic pressure to lever aside the electrical contactor cover following which a separate pneumatic piston operated to move the contacts forward into electrical mating. No environmental protection cover was used as an option in Concept 516b, in which case a sealing gasket was used around the periphery of the face of the electrical contactors to provide a tight seal between opposing electrical boxes when coupled. It should be noted that a large number of rapid transit electrical box covers have been reported to be removed following damage suffered in rapid transit service.

Other refinements which were noted to have good promise include the use of nylon bushings for all pivot points on the door (Concept 36). This was found to decrease door opening resistance under environmental conditions and improve the mechanical levering aside of the cover. Electric deicing has been tried in rapid transit service and has not been found to be effective because of mechanical difficulties encountered with this system between times when the deicing system was required for use. In addition, for rail freight service, electric deicing would only be operative on the one electric box attached to the power generating system and would not be applicable for cars during yard switching operations prior to their being coupled. A concept of applying plastic covers to the inner and outer surfaces of the connector covers was used in Concept 516b to protect electrical pins from an accidental short circuit in the event of a bent or damaged cover assembly.

4.2.4.3 Electrical Train Line Systems Of Compatible Add-On Types

In terms of specific add-on systems which are compatible with the Type "E" system, a minimum of new concepts were available

able for review and analysis. These are commented upon below with reference to the particular capabilities of each concept.

1) Concept 22: This is an added electrical connection device which is attached to the air connection system which is attached under the head of an "E" type coupler system. The best features of this electrical connector is that it utilizes the basic gathering capabilities and the spring-loaded seating capabilities of the basic air connector system.

2) Concept 502c: This electrical connection system is applicable only to a "F" type of system in that it is integrally attached with the air connector and is dependent upon the basic gathering capability of the "F" type coupler head in order to achieve the primary gathering of the air/electrical connector head. The electrical portion of this system utilizes the primary spring-loaded system for both the air and electrical final seating pressure. In addition, the electrical contacts are individually spring-loaded to maintain electrical continuity regardless of relative movement between the coupled "F" heads. Four butt-faced electrical contacts are spaced concentrically with the air seal on an approximate 4-inch diameter circle. The face of the connector could accommodate four additional contactors and still have adequate space for individual insulators of approximately 1.25 inches outside diameter. This electrical connector system does not have a system of sequencing or cover protection.

3) Concept 511c: This electrical connector is used in conjunction with the airline connector, Concept 511b, which contains sufficient gathering and centering to operate with a Type "E" coupler system. This system uses butt-type electrical contacts, which are held in place by the forward thrust of a

rubber ball universal and compression joint, which also serves the air connector system. The reliability of the electrical contacts is questionable without having a separate spring-loaded contact system. This concept contains an environmental cover over the electrical contactors, which is levered out of the way by the action of the two air connectors coming into mating. This cover is as vulnerable to potential coupling damage as is the "rigid" type of electrical connector covers. The redeeming feature of this cover-levering operation is that it is utilized on a relatively small electrical connector system and is located very close to the vertical centerline of the coupler head, thus reducing the potential for damage from wide angle couplings.

4) Concept 1200: This concept consists of an add-on electrical unit to be attached to a separate air connector system (such as Concepts 511b, or 22). The final seating action of the air connector gathering mechanism operates a valve in the face of the air connector unit. This valve then channels air line pressure (as quickly as it becomes available) to actuate a piston which thrusts the set of contact pins forward into electrical mating position. Loss of air pressure immediately causes the electrical contacts to retract and disengage. The primary disadvantages noted with this concept are the complexity of the air valve system and the potential difficulty of environmental grime interfering with the proper sliding forward of the contactor cylinder. It is believed that by clustering the electrical contacts around the air connector seal a more uniform seating of the electrical contacts would result. However, the application of separate air cylinders should allow this concept to maintain good electrical contacts.

4.2.4.4 Train Sensing and Control Systems

The concepts concerning sensing systems were almost universally related to the potential for such sensing systems as part of a train electrical system. The potential here is almost infinite and is a function of the amount of money which is to be spent in the sensing equipment. In rapid transit applications, the sensing systems were specifically aimed at detection of proper coupling and proper braking conditions within each individual car.

The concepts concerning control systems can best be reviewed in terms of the increasing complexity of the type of control established. In this sequence, coupling concepts included: brake control; single car uncoupling; general uncoupling; operating of uncoupling and air valves; operating of uncoupling, air valves, and centering devices; and total logic and control system.

1) Brake Control (Concept 45b): This vacuum control system would require a completely separate pneumatic line under vacuum conditions. It is considered an unreliable concept for application in freight trains because of the difficulty in maintaining a nonfluctuating vacuum throughout many inter-car connections.

2) Single Car Uncoupling (Concept 502c): This concept included electric control and operation of a single solenoid uncoupling system on the first car behind the locomotive. As such, it was not a universal system and was not deemed to be applicable to a full freight train.

3) General Uncoupling (Concept 1045): This system consisted of a locomotive control box with individual control boxes in each freight car. The system operated through a network of selecting switches, stepping switches, relays, four individual circuits through the car system, and operating switches and relays within each car. This concept, although valid, utilizes rotating and latching mechanical electrical switching devices which are subject to vibration and mechanical operational problems. Other solid state control devices are seen to be more appropriate for this type of application.

4) Operation Of Uncoupling And Air Valves (Concepts 33, 36, 301b, and 450a): These systems use electrical controls to operate electric solenoid valves and linear actuators.

5) Operation of Uncoupling, Air Valves, And Centering Devices (Concepts 27, 254, 503a, and 511a): These systems add the concept of controlling the centering device by engaging a latching lever or operating valves to activate air centering. Concept 511a utilizes an electrical device. In the other three concepts, and electropneumatic control system is utilized to energize the valves for air-operated centering devices.

6) Total Logic And Control System (Concepts 387, 450a, and 452): These systems all use solid state electronic multiplexing sensory and control systems which utilize a master control system in the locomotive and individual logic and control boxes within each freight car. This type of sensing requires a minimum of electrical interconnection lines (approximately five) in order to accomplish sensing and control functions relating to individual car uncoupling, air valve operation, centering devices, as well as having the potential for sensing inputs. These solid state

systems require a low electrical power transmission used to operate pilot valves which switch air pressure to accomplish all force functions.

4.2.4.5 Improve Operational Safety

Some elements of improvement and operating safety are inherent in each of the concepts which have been reviewed. These can be summarized into three basic areas of safety improvement as follows:

1) Direct improvement of safety of operating personnel. This is accomplished by automatic air connections, automatic operation of air valves, and remote operation of uncoupling apparatus.

2) Indirect improvement in safety for operating personnel by reducing bypass probability. This is accomplished through improved gathering range of coupler head, automatic positioning of the coupler head, and provision for the knuckle to be automatically opened with the uncoupling operation.

3) Direct improvement in operating safety through a lowering of derailment probability. This is accomplished through reduction of free slack, interlocking of coupler heads, entrapment features to hold a mated broken coupler head, and reduced contour angling potential.

5. CANDIDATE COUPLING SYSTEMS

5.1 BASIC PHILOSOPHY

In order to establish the candidate coupling systems, it is necessary to define the basic functional goals to be achieved by the new coupling systems. It seems reasonable to define the ultimate fully automatic coupler as any coupler system which will, without any manual assistance, couple two or more freight cars mechanically, pneumatically, and (if necessary for full system automation) electrically. Moreover, this fully automatic coupler system should maintain the coupled integrity with highest reliability through all reasonably anticipated service operating conditions.

One of the prime requisites of the fully automatic coupling system must be the ability of the two mating coupler heads to come together, without any previous manual guiding of the coupler head, in such a way that first-time coupling is assured. It is thus fundamental that the ultimate automatic coupling system should include provisions to preclude the possibility of a bypass or miscoupling for any reason.

5.2 DEGREE OF AUTOMATION

<u>It should be recognized that not all of the desired characteristics of a fully automatic coupler system are currently embodied in any one new concept or system</u>. The ultimate coupler system can be achieved only through improvements in present basic coupling subsystems or in the addition of new subsystems which give greater capability than that available with the present Type "E" coupler system.

To establish new candidate coupling systems, three basic subsystem areas were defined: coupling and uncoupling capability, air connection and brake valve system control, and full train line electrical systems and controls. The extent of the overall coupling system improvement will be a function of the degree of automation brought about by improvements to individual concepts as they are applied to each of the subsystems noted above.

None of the candidate coupling systems contain all of the potential degrees of improvement or automation which is possible in light of current technology. Each of the candidate coupling systems noted below, however, when taken through the suggested change steps, does represent a potential for achieving a fully automated coupler system which approaches the ultimate desired system.

5.3 PRELIMINARY CANDIDATE COUPLING SYSTEMS

Three different coupling design concepts were established as the basic coupling approaches on which to build three candidate coupling systems. These three basic coupling concepts are:

1) Free knuckle type coupler, which is fully compatible with (and a modification of) the present Type "E" coupler system.

2) Semirigid, spread-claw design, which is not compatible with the present Type "E" system but which represents the best of the concepts utilized in the UIC European synthesis freight car coupler designs and in the majority of mine car applications.

3) Rigid, flat-faced, horn-funnel design, features of most current rapid transit systems and some passenger service applications.

The realization of the potential for the full candidate coupling system is achieved through major change steps. These changes are based on a logical increase in system capability and degree of automation. In addition, the change steps take into consideration the system operating problems which would be involved in the retrofit program associated with these changes.

Listed below is a general description of the three candidate coupling systems and the change steps associated with the realization of each.

5.3.1 Compatible System #1

This system is based on utilization of modifications to the basic types "E" and "F" coupler head systems while maintaining the basic free knuckle coupling concepts and a total compatibility with all current U.S. freight lines.

5.3.1.1 Basic System 1-1A (Basic Subsystem for Short Cars)

This subsystem concentrates on changes to the Type "E" coupler head to increase gathering range, reduce free slack, achieve more positive locking of the coupler head, attain capability for vertical interlock and broken coupler entrapment, improve self-centering capabilities of draft gear, and ensure knuckles always being open following uncoupling.

5.3.1.2 Basic System 1-1B (Basic Subsystem for Long Cars)

This subsystem is primarily designed around the needs of the medium-length and longer cars, which require a longer coupler system length with its associated requirements for interlocking of the coupler head to achieve reduced contour angling. This subsystem centers on modification of the Type "F" interlocking head to achieve the following basic improvements: increased gathering range, achievement of positive locking, attainment of vertical interlock and entrapment of broken couplers for mated coupler heads, reduction of free slack, maintenance of positioning of the coupler head, and achievement of a knuckle open capability for the uncoupled units.

5.3.1.3 System Change 1-2 (Applicable to All Cars)

This change includes the addition of an automatic air connection and valve control system. The automatic air connection unit is coupler mounted and achieves connection of the air system below the coupler head. Salient features of this change are automatic air connection with coupling, automatic air valve control, push-button uncoupling capability from side of car, and provision for automatic control of train braking as a function of intentional or unintentional uncoupling action. This system retains the air hose/glad hand connection capability so that no adaptor system is required for a "mixed" car situation.

5.3.1.4 System Change 1-3 (Applicable to All Cars)

This change adds an electronic and electropneumatic control system for additional capabilities above those achieved by the basic subsystems with the Change 1-2. The primary elements of this system are: the addition of an electrical connector system to the already-attached air connector, the addition of an electropneumatic control system within each car, and the addition of an electronic multiplexing sensing and control system with master unit in the locomotive and logic systems in each car.

This final change would add the following capabilities to the total coupling system: automatic engagement control of the positioning device, selective car uncoupling capability from the locomotive, time delay provisions for setting brakes after intentional uncoupling, and provision for the potential for multiple sensing and control function through an electrical line and connector system.

5.3.2 System #2

This system is based on the UIC version of a simplified Willison coupler with a hinged hook design. This system offers potential for an extremely wide gathering range and greater capability for uncoupling in draft while achieving the potential for integral air and electrical connections with a limited number of circuit capacities.

Basic System 2-1 (Applicable to All Cars)

The basic system contains the primary coupling features with automatic air connection and valve control. Specific capabilities offered with this system include automatic air connection with coupling, automatic mechanical air valve operation, improved lateral and vertical gathering of approximately four times that of the Type "E" system, positive locking of mated couplers, reduced free slack, vertical interlock and entrapment for broken couplers of mated units, automatic centering of coupler, uncoupling capability from push button located at side of car, some uncoupling capability in draft, knuckle always open after uncoupling, possibility to manually lock out couplers to prevent coupling, and automatic control of braking under intentional or unintentional uncoupling situations.

This system does require the use of an air hose/glad hand adaptor in addition to a coupler head adapter unit when used in "mixed" car coupling situations.

5.3.3 System #3

This system is based on railroad adaptation of a proven rapid transit version of the Tomlinson coupler system which offers a capability for an increase in gathering range of approximately 2.5 times the Type "E" system, and the potential for addition of large numbers of electrical circuits for a sensing or control system.

5.3.3.1 Basic System 3-1 (Applicable to All Cars)

The basic system contains all of the coupler mechanical features as well as an integral air connector and valve control system. Features of this system include automatic air connection with coupling, automatic mechanical air valve operation, improved lateral and vertical ranges, positive locking of mated couplers, complete elimination of free slack, vertical interlock and trapment of broken couplers, reduced contour angling, automatic positioning, provision to initiate uncoupling from a push button at the side of the car, some uncoupling capability in draft, knuckles always open after uncoupling, and automatic control of setting of brakes with intentional or unintentional coupling.

This system requires an air hose/glad hand adapter unit plus a coupler head adapter unit when used in "mixed" coupling situations.

5.3.3.2 System Change 3-2 (Applicable to All Cars)

This change incorporates the addition of electropneumatic and electronic control systems which add the same capabilities as described for System Change 1-3. In addition, this system allows provisions for a great number of electrical circuits (perhaps up to 100), should this be determined to be a desirable capability for later sensing and control systems.

5.4 PRELIMINARY ENGINEERING ANALYSIS

A preliminary engineering analysis of the various individual concepts was included in Section 4. The features and capabilities of each coupling system represent the total of the capabilities of the contained concepts within each system with some interaction modifications. An engineering summary of the combined features of the preliminary candidate coupling systems are included in Tables 5-1 through 5-8. The format for presentation of the three candidate systems is as follows:

1) Compatible System #1
   - (a) Basic System 1-1A, Short Car
   - (b) Basic System 1-1B, Long Car
   - (c) System Change 1-2, Addition of Air Connector and Valve Control System
   - (d) System Change 1-3, Addition of Electropneumatic Control System
2) Noncompatible System #2, Semirigid, Spread-Claw
   - (a) Basic System 2-1
   - (b) System Change 2-2, Addition of Electropneumatic Control Systems
3) Noncompatible System #3, Rigid, Flat-Faced
   - (a) Basic System 3-1
   - (b) System Change 3-2, Addition of Electropneumatic

Control Systems

These tables are structured to show the following analysis about each candidate coupling system:

1) Operational characteristic impoved or modified by this coupling system.

2) Concept description and operating features.

3) Primary bibliography reference number.

4) Possible alternate design realization bibliography reference numbers.

5) Estimated quantitative values of improvement.

5.4.1 Principal Operating Features

Listed below are the principle operating characteristics and features of each of the coupling systems and the changes made.

5.4.1.1 Compatible System #1

This system is built around concepts which are totally compatible with the present Type "E" coupler system. For the two basic systems and each of the two system changes, there would be no requirement for separate adapters in order to make this system compatible when used in a "mixed" car system. Pertinent operating features of the systems are as follows:

1) Basic System 1-1A, Short Car (Table 5-1)

The Basic Short Car System 1-1A is built around the capabilities of the standard Type "E" coupler head with changes to add a top and bottom shelf with guard-arm extensions, changing

TABLE 5-1.--CANDIDATE COUPLING SYSTEMS - COMPATIBLE SYSTEM NUMBER 1-1A (BASIC SHORT CAR SYSTEM)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE MECHANICAL COUPLING				
<u>Automatic Engagement</u>				
Lateral Gathering Range	. Coupler knuckle contour change.	501	502	6.875" (1.7 x standard)
Vertical Gathering Range	. Guard arm extension faces on top and bottom shelves.	702		Approximately 6" (2 x standard)
Positive Locking	. Compatimatic* coupler head (positive mechanical rotation of lockset by force of mating coupler head).	502		
<u>Positive Retainment</u>				
Wider Coupler Speed Range	. Compatimatic* coupler head with mechanical forced unlocking.	502		
Reduced Free Slack	. Revise front shape of knuckle (add 5/64" to front face).	501		0.625" (0.8 x standard)
Vertical Interlock and Broken Coupler Entrapment	. Top and bottom coupler shelf (self-interlocking to prevent both top and bottom slip-over).	54	702	
<u>Location Control</u>				
Self Centering	. Self centering draft gear/shank design (draft gear compression forces act to bias shank laterally).	26	1,151	±2" (0.6 x standard)
<u>Reduced Maintenance</u>	. Lubrication fittings at coupler head and shank wear points.	503		
IMPROVE MECHANICAL UNCOUPLING				
<u>Recoupling Capability</u>				
Knuckle Always Open	. Compatimatic* coupler head (knuckle is spring loaded in open position when uncoupled).	502		
IMPROVE GENERAL SYSTEMS				
<u>Operational Safety</u>	. Blunt and round front edges of coupler and shelves (reduced possibility of rupture of tank car in derailment situation).	54		Estimated 60% reduction of rupture probability
ADAPTER TO MAKE COMPATIBLE WITH AAR TYPE "E" SYSTEM	. Not required.	N/A		
	Note: (*) Developed by National Castings Division, Midland Ross Corporation.			

of the knuckle contour, and revision of the front shape of the knuckle. These basic changes result in the improved capabilities of increased lateral gathering range to 6.875 inches, increased vertical gathering range to approximately 6 inches, reduced free slack to 0.625 inch, and vertical interlock to prevent the slipover of mated type "E" couplers and to entrap a broken mated coupler. The capability of increased gathering is augmented by the addition of self-centering draft gear which use the force of the compressed draft gear to bear on an offset in the shank to force recentering of the shank to within 2 inches of center. The combination of an increase in lateral gathering to 6.875 inches with self-centering should properly align couplers for mating under almost all switching operations.

To achieve absolute coupling capability, a change to the Compatimatic* coupler head has been added. This concept keeps the knuckle of an uncoupled unit in the open position by the use of a preloading spring device. The Compatimatic* concept includes a "sensing mechanism" that disengages the knuckle open feature upon mating with another coupler. The Compatimatic* also assures positive locking by a mechanical rotation of the lockset by the force of the mating coupler head.

The Compatimatic* coupler concept, similar to the standard Type "E" system, has a minimal capability for uncoupling in draft. The basic design of the free knuckle type of coupler is such that a draft or tension force on the knuckle causes the pivot arms to squeeze against the locking mechanism of the coupler. Since uncoupling is initiated by mechanically lifting the lock up and away from the rear of the knuckle, the forces applied by draft are such that this type of coupler essentially cannot be uncoupled in draft.

Note: (*) Developed by National Castings Division, Midland Ross Corporation.

Two other features included in this coupling system relate to reduced maintenance and improved safety. Field reports indicate that a light greasing of the locking components exerts a greater influence on locking and unlocking reliability than does surface roughness of the locking pieces or other environmental factors. Thus, lubricated fittings are added at strategic points in the coupler head and shank wear points.

Recent safety tests have indicated that the leading edges of overriding couplers could act like a "punch" to pierce a tank car head during a derailment situation. This coupling system has an added concept of blunting and rounding the front edges of a coupler and the added shelves to increase safety.

2) Basic System 1-1B, Long Cars (Table 5-2)

This coupling system is built around the same basic concepts as the Short Car System 1-1A except that it utilizes the Type "F" interlocking coupler head as the basic unit. As previously discussed in Section 4, long cars require an interlocking coupler head in order to reduce the contour angling which would otherwise occur with the required long shank. The Type "E" coupler head with the double shelf addition is still inadequate in terms of needed interlocking for the long car coupler head.

The regular bell-housing for the long shank couplers allows a lateral movement of approximately plus or minus 15 inches at the coupler head. Even if absolute centering were achieved for the coupler, the 6.875 inches lateral gathering offered with this system would be inadequate to cover the approximately 15 inches of offset, which is possible as cars approach tangent at crossovers or maximum curvature points. This candidate system therefore utilizes a positioning device to steer the coupler head

TABLE 5-2.-CANDIDATE COUPLING SYSTEMS - COMPATIBLE SYSTEM NUMBER 1-1B (BASIC LONG CAR SYSTEM)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE MECHANICAL COUPLING				
<u>Automatic Engagement</u>				
Lateral Gathering Range	. Coupler knuckle contour change.	501	502	6.875" (1.7 x standard)
Vertical Gathering Range	. Type "F" interlocking coupler head.	428		4.5" (1.5 x standard)
Positive Locking	. Compatimatic* coupler head (positive mechanical rotation of lockset by force of mating coupler head).	502		
<u>Positive Retainment</u>				
Wider Coupler Speed Range	. Compatimatic* coupler head (with mechanical forced unlocking).	502		
Reduced Free Slack	. Revise front shape of knuckle (add 5/64" to front face).	501		Approximately 0.3" (0.4 x standard)
Vertical Interlock and Broken Coupler Entrapment	. Type "F" interlocking coupler head (interlocking arm pocket).	428		
	. Top coupler shelf (to prevent top slipover of type "E" mated coupler).	52		
<u>Location Control</u>				
Reduced Contour Angling	. Type "F" interlocking coupler head.	428		Lateral = 3.75° rocking Vertical = 2° rocking, 0.125" sliding
Automatic Positioning	. Hydraulic, direct guided coupler positioning device.	31		Eliminate estimated 90% of bypasses
	. Vertical spring carrier system.	25		
<u>Reduced Maintenance</u>	. Lubrication fittings at coupler head and shank wear points.	503		
	Note: (*) Developed by National Castings Division, Midland Ross Corporation.			

TABLE 5-2.-CANDIDATE COUPLING SYSTEMS - COMPATIBLE SYSTEM NUMBER 1-1B (CONTINUED)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS PRIMARY	POSSIBLE ALTERNATE	ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
IMPROVE MECHANICAL UNCOUPLING				
Recoupling Capability				
Knuckle Always Open	. Compatimatic* coupler head (knuckle is spring loaded in open position when uncoupled).	502		
IMPROVE GENERAL SYSTEMS				
Operational Safety	. Blunt and round front edges of coupler and top shelf (reduced possibility of rupture of tank car in derailment situation).	52		Estimated 60% reduction of rupture probability
ADAPTER TO MAKE COMPATIBLE WITH AAR TYPE "E" SYSTEM	. Not required.	N/A		
	Note: (*) Developed by National Castings Division, Midland Ross Corporation.			

toward the center of the tracks. The combination of this positioning device and the built-in lateral gathering range of 6.875 inches should result in an elimination of approximately 90 percent of bypass situations involving long cars.

The knuckle contour change and Compatimatic* head concepts are the same as for system 1-1A. This system also includes a top coupler shelf which is required to prevent top slipover of a Type "E" coupler which would be mated to this Type "F" coupler system.

3) System Change 1-2, Addition of Air Connector and Valve Control System (Table 5-3)

As the next significant step in increasing the degree of automation, this system change adds an automatic air connector and valve control system to the basic candidate coupling systems 1-1A and 1-1B.

The air connector system chosen for this candidate system is the coupler mounted, spread-wing type with butt facing air seals. The air connector has built-in 5-inch lateral and 4-inch vertical gathering range such that it will operate satisfactorily when mounted independently with the Type "E" system 1-1A as well as with the Type "F" system 1-1B. A simpler air connector system could have been chosen for application on the Type "F" equipped cars; however the use of one standard air connector system is believed much superior for both economy of production and ease of making effective air connections between "mixed" cars. The proposed air connector system, in addition, has already been subjected to several years of field trials and has a proven potential to meet all general service requirements.

Note: (*) Developed by National Castings Division, Midland Ross Corporation.

TABLE 5-3.--CANDIDATE COUPLING SYSTEMS - COMPATIBLE SYSTEM NUMBER 1-2 (ADDITION OF AIR CONNECTION AND VALVE CONTROL SYSTEM)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE TRAIN AIR LINE SYSTEM				
Automatic Control				
Automatic Air Connection	. Automatic air connection system with horizontal articulation capability.	22 1,192	511, 502	Lateral = 5"; Vertical = 4"; Angular = 7°
Automatic Air Valve Control	. Automatic mechanical air valve operation (mechanical push rod in face of air connector initiates valve action).	22		
Improved Performance				
Air Seal Leak Rates, Hose Reliability and Reduced Maintenance	. Automatic air connection system.	22		
IMPROVE MECHANICAL UNCOUPLING				
Uncoupling Capability				
Push Button Release	. Remote uncoupling button at side of car (opens air valve).	674		
	. Hydraulic uncoupling operating mechanism (direct pneumatic operation of standard uncoupling linkage).	943		
IMPROVE GENERAL SYSTEMS				
Automatic Train Brake Control	. Provide for nonbraking (retention of air) after intentional uncoupling.	22		
	. Provide for emergency braking after unintentional uncoupling (immediate release of air). (Operation of uncoupling lever initiates valve action.)			
ADAPTER TO MAKE COMPATIBLE WITH AAR TYPE "E" SYSTEM	. Air hose/glad hand connection capability retained (on opposite side of coupler head) - no other adapter required.	22		

The air valve control system is integrated with the air connector system to achieve automatic mechanical operation of the air valves as part of the coupling and uncoupling operation. This air valve control system consists of a low pressure line interface valve, a main air line valve (operated from a low pressure puffer cylinder), and an uncoupling valve operated by the standard uncoupling lever. The basic operation of this system is as follows:

(a) As the mechanical couplers are brought together to couple, the train line connectors gather and seat with the opposing air connector. The primary airline and pilot airline seals are butt faced and are pushed back against a loading spring which assures intimate contact for air pressure seal and retention during all normal service conditions. Coincident with final coupling, the actuator plunger on the face of each connector is contacted and depressed by the flat opposing connector face. This plunger operates a flexible cable or hydraulic line which opens the control valve (low pressure) which allows the low pressure to operate an interface valve which opens the main train airline valve.

(b) Uncoupling is initiated by the use of the standard uncoupling lever. Just after the mechanical coupler lock has reached the lock-set position, the uncoupling rod actuates an uncoupling valve which, working in conjunction with the pilot line system, closes the train main airline valve. In the event of an unintentional uncoupling, the main airline valves remain open to achieve an automatic setting of emergency brakes at the parting of the couplers.

(c) When coupling this air-connector equipped system to a nonequipped car, the coupling procedure is essentially identical to the current coupling practice. The only difference is that the angle cock on an air-connector equipped car is relocated to the left hand side of the coupler so that the hoses are coupled directly across, eliminating any possible interference with the air connector head. Similarly, uncoupling (between mixed system cars) is carried out with the normal current procedure.

This candidate coupling system also includes the potential for a remote uncoupling release capability. This is accomplished by the addition of an uncoupling push button at the side of the car which works in conjunction with a pneumatic uncoupling operating mechanism which operates the standard uncoupling linkage.

This system retains a standard air hose/glad hand connection capability (located on the opposite side of the coupler head), which precludes the need for an interchange device should the air connector equipped car be coupled with a "mixed" car.

4) System Change 1-3, Addition of Electropneumatic Control System (Table 5-4)

This change adds: an electrical connector system (as a rigid part of the air connector unit); an electropneumatic servo control system at each coupler; an electronic, solid-state multiplexed sensing and control system (master system in locomotive and logic system in each car); and an optional microwave receiving and control system in the locomotive should remote operation be desired.

The electrical connector system is rigidly attached beneath the air connector head such that the primary forward thrust for the electrical connector is obtained by the spring-loading mechanism of the air connector unit. The electrical contactor

TABLE 5-4.-CANDIDATE COUPLING SYSTEMS - COMPATIBLE SYSTEM NUMBER 1-3 (ADDITION OF ELECTRO-PNEUMATIC CONTROL SYSTEM)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE MECHANICAL COUPLING				
Location Control	. Automatic disengagement of centering/positioning device at coupling and engagement at uncoupling (electro-pneumatic engagement of positioning device 31b).	254		
IMPROVE MECHANICAL UNCOUPLING				
Uncoupling Capability	. Electro-pneumatic control system to initiate uncoupling from electric signal within train (to operate pneumatic uncoupling mechanism Number 943).	254		
IMPROVE GENERAL SYSTEMS				
Automatic Train Brake Control	. Provide time delay set provisions for brakes after intentional uncoupling (from electrical signal to timing delay system in pneumatic uncoupling control 245).	254		
Electrical Train Line System	. Add electrical connector system (rigid attached at bottom of air connector).	1,200	502	
	. Air piston sequencing of contractors after mechanical connection.	1,200	516, 254	
	. Up to 6-8 circuits of butt face, spring loaded, rotating type.	450		
	. Utilize silver plated or silver button tipped contactors.	516		
	. Provide mechanical hand back-up contactor engagement.	516		
	. Provide maintenance removal potential for mated contactors.	254	309	
	. Provide environmental cover with opening by pneumatic sequencing after mechanical mating (initiated by coupling push rod).	301		
	. Provide nylon hinges for environmental cover.	36		
	. Provide plastic insulators over environmental cover.	516		
	. Provide rubber environmental sealing gasket at edge of contactor block.	516		

TABLE 5-4.-CANDIDATE COUPLING SYSTEMS - COMPATIBLE SYSTEM NUMBER 1-3 (CONTINUED)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE GENERAL SYSTEMS (CONTINUED)				
<u>Sensing and Control System</u>	. Electro-pneumatic servo control system at each coupler.	254		
	. Electronic, solid state multiplexing sending and control system (master system in locomotive and logic system in car).	452	450, 387	
	. Optional microwave receiving and control system in locomotive.	450		
ADAPTER TO MAKE COMPATIBLE WITH AAR TYPE "E" SYSTEM	. Not required.	N/A		

consists of 6 to 8 circuits of butt face, spring loaded, rotating type silver-plated contacts which are brought into engagement by the forward thrust of a piston holding unit. At the time of mating, the air connector unit makes complete seating with a mechanical push rod being closed which results in valving air pressure into a pneumatic circuit which opens the cover from the electrical contacts and then sequences the contacts into position by energizing an air piston unit which contains the electrical circuits.

A solid-state electronic multiplexing sensing and control system is utilized in the locomotive for control of car uncoupling systems and for potential use as a decoding system for sensing units which could later be placed in different cars. This solid-state electronic control unit would transmit low power signals through the electrical contact circuit using a binary coded impulse control system. In this concept, it would not be required to transmit high electrical power signals since the low power electronic signals would be used to energize servo units at each car which, in turn, would switch pilot and air valve systems which would accomplish all forcing or operating functions from pneumatic power. These low power electronic signals would be picked up by a logic sensing system located in each car.

The heart of the active control efforts would be accomplished by an electropneumatic servo control system located at the coupler. Circuits in this unit would be energized by mechanical closure devices (such as a push rod) at the time of coupling and electrical or mechanical inputs indicating a desired intentional uncoupling.

Should it be desired to exercise external control over the various uncoupling or braking functions, an optional microwave receiving and control system would be established in the locomotive. It is not believed feasible to interject direct microwave reception into individual car units because this would require an independent power system to be available in each car with the associated unrealistic requirements for maintenance of battery power in uncontrolled freight car storage and standby conditions. With the availability of the locomotive engineer and the electronic multiplexing sensing and control system in the locomotive, it is believed more feasible to utilize the engineer and his control system as the contact point between the train and its external program input.

This electronic and electropneumatic control system does not compromise the normal inter-car connection sequence and no adaptor units are required to make this system compatible in a "Mixed" car system.

5.4.1.2 Noncompatible System #2

This system is built around the basic coupling concept of the Willison principle as embodied in the Unicupler design of the UIC synthesis coupler. This is a semirigid, spread-claw design type which incorporates a large gathering range together with a capacity for internal mounting of air and electrical connectors.

1) Basic System 2-1, All Cars (Table 5-5)

The Unicupler UIC Synthesis design (Concept 309) retains

TABLE 5-5.-CANDIDATE COUPLING SYSTEMS - NONCOMPATIBLE SYSTEM NUMBER 2-1 (SEMIRIGID, SPREAD CLAW, BASIC SYSTEM)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE TRAIN AIR LINE SYSTEM				
<u>Automatic Control</u>				
Automatic Air Connection	. Spring loaded integral air connection.	503	448	
	. Double concentric compressible rubber seals.	45		
Automatic Air Valve Control	. Automatic mechanical air valve operation (mechanical push rod in face of coupler head initiates valve action).	22	36, 301	
<u>Improved Performance</u>				
Air Seal Leak Rates and Hose Reliability	. Automatic air connection system.	503 45	448	
Reduced Maintenance	. Pivoted rear removal of air connection assembly.	309		
IMPROVE MECHANICAL COUPLING				
<u>Automatic Engagement</u>				
Improve Lateral and Vertical Gathering Ranges	. Spread claw gathering of semirigid coupler head	309	457	± 8.7" (4.3 x standard) lateral ± 5.5" (3.7 x standard) vertical
Positive Locking	. Spring loaded locking hook with spring energized locking mechanism.	309		
<u>Positive Retainment</u>				
Wider Coupling Speed Range	. Spring loaded locking hook (positive snap lock at coupling).	309		
Reduced Free Slack	. Cast/forged coupler head with machined seating faces.	309		
Vertical Interlock and Broken Coupler Entrapment	. Interlocking gathering claws and locked mated hooks.	309	301	0.3" (0.4 x standard)
<u>Location Control</u>				
Self Centering	. O.R.E. II cross beam support centering device.	318	41	± 1.2" (0.34 x standard)
	. Vertical spring carrier system.	25		
Reduced Contour Angling	. Semirigid coupler head with interlocking claws.	309		
<u>Reduced Maintenance</u>	. Lubrication fittings at coupler head and shank wear points.	503		

TABLE 5-5.-CANDIDATE COUPLING SYSTEMS - NONCOMPATIBLE SYSTEM NUMBER 2-1 (CONTINUED)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE MECHANICAL UNCOUPLING				
<u>Uncoupling Capability</u>				
Alternate Side Lever, or	. Second uncoupling lever with cable connection.	309		
Push Button Release	. Remote uncoupling button at side of car (to operate air valve in coupler head for uncoupling release).	674		
In Draft	. Air cylinder release of rotary locking block in coupler head (provides force boost for uncoupling in draft).	391	33, 9	Up to 8,000 pounds draft force
<u>Recoupling Capability</u>				
Knuckle Always Open	. Spring loaded locking pawl (spring cocked at unloading).	309		
Prevent Recoupling	. Manual lock open of locking pawls to prevent locking (to allow yard movement without automatic coupling lock).	309	457	
IMPROVE GENERAL SYSTEMS				
<u>Automatic Train Brake Control</u>	. Provide for nonbraking (retention of air) after intentional uncoupling.	22		
	. Provide for emergency braking after unintentional uncoupling (immediate release of air). (Operation of uncoupling lever initiates valve action.)	22		
ADAPTED TO MAKE COMPATIBLE WITH AAR TYPE "E" SYSTEM	. Air hose/glad hand adapter (plus) coupler head adapter knit is required.	22 301		

the same basic Willison coupling profile (i.e., rigid cast knuckle with fixed side gathering claw) but is a larger and deeper unit such that the gathering forces are completed prior to the final longitudinal mating of the couplers. Thus there are straight butt forces involved at the final coupling which allow for butt type air and electrical connections to be designed as an integral part of the interior of the coupler. In addition, the final locking is done by a hinged locking hook which requires less lateral movement on the part of the coupler in order to achieve complete mating.

The gathering features are such that it has a capability of lateral gathering of plus or minus 8.7 inches and vertical gathering of plus or minus 5.5 inches. Both represent a significant increase of approximately four times over the gathering capabilities of the basic Type "E" coupling system.

The Unicupler has a reduced free slack of approximately 0.3 inch, which does allow the integral mounting of air and electrical connectors so long as they retain the capability of self-seating (i.e., contain compressible rubber air seals and spring back-up loading for both air and electrical). These later features have been embodied in the basic design as concepts chosen from other coupler systems.

The spring-loaded locking hooks achieve a positive snap lock at coupling which, together with the interlocking gathering claws, effectively accomplishes a vertical interlock and entrapment capability for a broken coupler. The location of the locking hooks on the upper portion of the spread-claw area allows room for the air connection system on the lower center line of the coupler. This location allows for the removal potential of the air connection assembly from the rear of the coupler, thus offering significant opportunities for maintenance of the air seal assembly even with the couplers in the mated condition.

With the wide natural gathering of the Unicupler, only a centering device is required in order for this coupler to be in a position to make an effective coupling (without bypass) for virtually all operating situations. It is realized that a positioning device would still slightly improve the mating potential for long cars; however, it is believed that the nominal decrease in bypass probability for a small percentage of active freight cars does not outweigh the potential advantages of having an identical coupler system on all cars with the associated potential for standardization of centering control devices.

Although manual uncoupling is provided, the primary uncoupling force results from air cylinder operation of a rotary locking block. This feature provides a capability for a force boosting of the uncoupling forces to allow an coupling in draft of an 8,000 pounds draw-bar pull. This is not a significant draft force when compared to potential full train situations; however, this represents a potential for further automation of hump switching operations by providing for uncoupling under nominal draft forces. The use of an air cylinder boost for uncoupling allows an alternate uncoupling system to be used including a button type release at the side of the car. This also has the potential for significant improvement in trainman safety in hump-switching operations.

The Unicupler has the feature of the "knuckle" always being open due to a spring loaded locking pawl which is set at uncoupling. One particularly unique feature of the Unicupler is the capability for a manual "lock open" of the locking pawls in order to prevent the coupler from locking when it comes into contact with another coupler. This allows for alternate yard switching movements in which it is possible to relocate cars without a yardman being present to uncouple the cars after movement has been completed.

This system contains another concept (Concept 22) which automatically opens or closes the main train valve as a function of mechanical forces (i.e., movement of a push rod in the face of the coupler at coupling or operation of the uncoupling lever). This feature, together with the automatic air connection, eliminates the need for a trainman to go between cars during either the coupling or uncoupling operations.

The Unicupler, being a noncompatible system, does require the use of an air hose/glad hand adapter plus a coupler head adapter unit in order to mate with nonequipped cars. The air hose/glad hand adapter is a standard feature embodied in Concept 22. This requires no extra handling or equipment on the part of the trainmen. On the other hand, the coupler head adapter unit would involve a rather complicated and heavy unit to be securely attached to the face of the Unicupler and at the same time to have a front facing head unit which would properly mate with the Type "E" coupler system. During any transition period involving a change to this system, a significant number of adapter units would be required throughout the railroad system as well as a change in procedures to fit the adapter units to those cars which are to be placed into "mixed" rail service.

2) System Change 2-2, Addition of Electropneumatic Control System (Table 5-6)

This system embodies all of the concepts as related in

TABLE 5-6.-CANDIDATE COUPLING SYSTEMS - NONCOMPATIBLE SYSTEM NUMBER 2-2 (ADDITION OF ELECTRO-PNEUMATIC CONTROL SYSTEM)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE MECHANICAL COUPLING				
Location Control	. Automatic disengagement of centering at coupling and engagement at uncoupling (electro-pneumatic engagement of centering device 318).	254		
IMPROVE MECHANICAL UNCOUPLING				
Uncoupling Capability	. Electro-pneumatic control system to initiate uncoupling from electrical signal within train (to operate pneumatic uncoupling mechanism 391).	254		
IMPROVE GENERAL SYSTEMS				
Automatic Train Brake Control	. Provide time delay set provisions for brakes after intentional uncoupling (from electrical signal to timing delay system in pneumatic uncoupling control 254).	254		
Electrical Train Line System	. Add electrical connector integral to coupler head.	36	309, 33	
	. Air piston sequencing of contactors after mechanical connection.	1,200	516, 254	
	. Up to 6-8 circuits of butt face, spring loaded rotating type.	450		
	. Utilize silver plated or silver button tipped contactors.	516		
	. Provide mechanical hand back-up contactor engagement.	516		
	. Provide maintenance removal potential for mated contactors.	309		
	. Provide environmental cover with opening by pneumatic sequence after mechanical mating (initiated by coupling push rod).	301		
	. Provide nylon hinges for environmental cover.	36		
	. Provide plastic insulators over environmental cover.	516		
	. Provide rubber environmental sealing gasket at edge of contactor block.	516		

TABLE 5-6.-CANDIDATE COUPLING SYSTEMS - NONCOMPATIBLE SYSTEM NUMBER 2-2 (CONTINUED)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE GENERAL SYSTEMS (CONTINUED)				
Sensing and Control System	. Electro-pneumatic servo control system at each coupler.	254		
	. Electronic, solid state multiplexing sensing and control system (master system in locomotive and logic system in car).	452	450, 387	
	. Optional microwave receiving and control system in locomotive.	450		
ADAPTER TO MAKE COMPATIBLE WITH AAR TYPE "E" SYSTEM	. No additional adapters required.	N/A		

compatible System 1-3. Although applied to a different physical coupler system, the same concepts would evidence the same type of controlling features as previously noted. The same limitations of approximately six to eight electrical circuits applies for System 2-2 as for System 1-3. There would be adequate space for 6-8 circuits, assuming that only one of the circuits would be a power conducting unit with the other circuits being reserved for low power signals related to the use of solid state electronic multiplexed control circuits.

5.4.1.3 Noncompatible System #3

This system is a rigid, flat-face, horn-funnel coupler system of the SW-800 type (Concept 9). The general features of this coupler system are shown schematically in Figure 4.3. This system represents an enlarged version of similar coupler units which have proven to be effective in rapid transit service and, to a lesser extent, in passenger rail service.

1) Basic System 3-1, All Cars (Table 5-7)

The SW-800 coupler system embodies the latest features of the basic Tomlinson principle of coupling. In this system, a hook/funnel technique is used for gathering and final locking of the couplers together.

The "protruding horn" or hook is guided into a funnel shape recessed area of the adjacent coupler, which allows a lateral gathering range of approximately ± 5 inches (which is 2.5 times that of the Type "E" coupler system) and a vertical gathering range of $\pm$ 5 inches (3.3 times the rule 20 AAR interchange requirement). As the funnel guides the mating horn into position, the couplers engage final alignment pins in aligning holes with the

TABLE 5-7.-CANDIDATE COUPLING SYSTEMS - NONCOMPATIBLE SYSTEM NUMBER 3-1 (RIGID, FLAT FACE, BASIC SYSTEM)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE TRAIN AIR LINE SYSTEM				
<u>Automatic Control</u>				
Automatic Air Connection	. Spring loaded, compressible rubber, integral air connector.	9	503, 448	
Automatic Air Valve Control	. Automatic mechanical air valve operation. (Mechanical push rod in face of coupler head initiates valve action.)	22	36, 301	
<u>Improved Performance</u>				
Air Seal Leak Rates, Hose Reliability and Reduced Maintenance	. Automatic air connection system.	9	503, 448	
IMPROVE MECHANICAL COUPLING				
<u>Automatic Engagement</u>				
Improve Lateral and Vertical Gathering Ranges	. Horn-funnel gathering of rigid coupler head.	9	301, 6	± 5" (2.5 x standard) lateral ± 5" (3.3 x standard) vertical
Positive Locking	. Spring loaded locking hook and direct locking catch (from compression of guide pins on coupler face).	9		
<u>Positive Retainment</u>				
Wider Coupling Speed Range	. Spring loaded locking hook (positive interlock at coupling).	9		
Reduced Free Slack	. Machined flat mating front faces and locking detents.	9		Zero free slack (design nominal)
Vertical Interlock and Broken Coupler Entrapment	. Interlocking horns with locked hooks and aligning pin/dowel interlock.	9	6	
<u>Location Control</u>				
Reduced Contour Angling	. Rigid coupler heads with interlock.	9		
Automatic Positioning	. Hydraulic, direct guided coupler positioning device.	31		
	. Vertical spring carrier system.	25		

TABLE 5-7.-CANDIDATE COUPLING SYSTEMS - NONCOMPATIBLE SYSTEM NUMBER 3-1 (CONTINUED)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE MECHANICAL COUPLING (CONTINUED)				
Reduced Maintenance	. Lubrication fittings at coupler head and shank wear points.	503		
IMPROVE MECHANICAL UNCOUPLING				
Uncoupling Capability				
Push Button Release	. Remote uncoupling button at side of car (to operate self-contained pneumatic uncoupling release).	674		
In Draft	. Locking hooks forced apart by cam wedge force (from pneumatic cylinder through rotary locking block) to provide force boost for uncoupling in draft.	9 391	33	Up to 8,000 pounds draft force
Recoupling Capability				
Knuckle Always Open	. Spring loaded locking hook (set ready at uncoupling).	9	301, 6	
IMPROVE GENERAL SYSTEMS				
Automatic Train Brake Control	. Provide for nonbraking (retention of air) after intentional uncoupling.	22		
	. Provide for emergency braking after unintentional uncoupling (immediate release of air) (operation of uncoupling lever initiates valve action).	22		
ADAPTER TO MAKE COMPATIBLE WITH AAR TYPE "E" SYSTEM	. Air hose/glad hand adapter (plus) coupler head adapter unit is required.	9		

final close tolerancing of these pins and holes giving a "slack free" characteristic to the coupler. This system thus represents a significant increase in gathering range over the Type "E" system.

The total gathering capabilities of this system are functions of the size of the hood cross-section, with the horizontal and vertical gathering ranges being equal to or slightly less than the corresponding hook dimensions. This gathering range can be increased by a factor of 1.3 to 1.4 by the addition of an extra protruding gathering horn. However, in the systems embodying this protruding horn principle, it has been determined that the horn design is marginal in its strength and resistance to impact damage. This concept is therefore not believed to be appropriate for use as a major gathering element in a freight train application.

The spring-loaded locking hook is set ready at uncoupling to achieve a "knuckle open" capability. These hooks are positively locked in place at coupling by a direct compression of a locking catch by guide pins on the coupler face. This positive locking mechanism is the best of the candidate coupling systems.

Uncoupling can be initiated by either a hand-operated lever or with air cylinder force boosting. This latter feature allows the incorporation of a side-of-car push button release as well as allowing the coupler to have uncoupling capabilities under draft forces. The uncoupling energy (from hand lever or air cylinder) forces hook retractors between opposing faces of the locking hooks. These retractors act as wedges to give leverage for hook separation under draft forces. Concept 391 has been added to include a rotary locking block actuation by the pneumatic cylinder to increase the capabilities of uncoupling in draft forces up to about 8,000 pounds.

The same air valve control system (Concept 22) has been suggested here as for the other systems giving this system an equal capability with respect to automatic air valve control at coupling and uncoupling.

Since this coupler is totally rigid and depends on a proper seating of flat coupler faces, it is more susceptible to potential damage from oblique coupling impact than is the case for either of the other systems. It is therefore concluded that this system is required to have a positioning device in order to operate effectively on either long or short cars. The very rigid nature of the coupling also requires a vertical spring carrier system in order to provide the vertical articulation which is necessary for operating over vertical curves.

This system also requires adapter units for operations in "mixed" coupling situations. The air hose/glad hand adapter as proposed presents no problem for Concept 22. On the other hand, the coupler head adapter unit will be sophisticated and heavy and will require special handling procedures throughout any transitional period for change to this type of coupling system.

2) System Change 3-2, Addition of Electropneumatic Control System (Table 5-8)

The proposed system is identical to that suggested for System 1-3 and 2-2 and offers the same control concept capabilities although being embodied in a different physical coupler situation. The outstanding capability for this rigid type coupler system is the potential availability of an exceedingly large number of electrical circuits. Potential designs for the

TABLE 5-8.-CANDIDATE COUPLING SYSTEMS - NONCOMPATIBLE SYSTEM NUMBER 3-2 (ADDITION OF ELECTRO-PNEUMATIC CONTROL SYSTEM)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE MECHANICAL COUPLING				
Location Control	. Automatic disengagement of centering/positioning device at coupling and engagement at uncoupling (electro-pneumatic engagement of positioning device 31b).	254		
IMPROVE MECHANICAL UNCOUPLING				
Uncoupling Capability	. Electro-pneumatic control system to initiate uncoupling from electrical signal within train (to operate pneumatic uncoupling mechanism 9,391).	254		
IMPROVE GENERAL SYSTEMS				
Automatic Train Brake Control	. Provide time delay set provisions for brakes after intentional uncoupling (from electrical signal to timing delay system in pneumatic uncoupling control 254).	254		
Electrical Train Line System	. Add electrical connection box below face of coupler head.	9	27, 391, 503, 511	
	. Air piston sequencing of contactors after mechanical connection.	254	516	
	. From 50-100 circuits of butt face, spring loaded, rotating type.	450		
	. Utilize silver plated or silver button tipped contactors.	516		
	. Provide mechanical hand back-up contactor engagement.	516		
	. Provide maintenance removal potential for mated contactors.	254		
	. Provide environmental cover with opening by pneumatic sequencing after mechanical mating (initiated by coupling push rod).	301		
	. Provide nylon hinges for environmental cover.	36		
	. Provide plastic insulators over environmental cover.	516		
	. Provide rubber environmental sealing gasket at edge of contactor block.	516		

TABLE 5-8.--CANDIDATE COUPLING SYSTEMS - NONCOMPATIBLE SYSTEM NUMBER 3-2 (CONTINUED)

OPERATIONAL CHARACTERISTIC WITHIN THE OVERALL COUPLING SYSTEM	CONCEPT DESCRIPTION	BIBLIOGRAPHY REFERENCE NUMBERS		ESTIMATED QUANTITATIVE VALUES OF IMPROVEMENT
		PRIMARY	POSSIBLE ALTERNATE	
IMPROVE GENERAL SYSTEMS (CONTINUED)				
Sensing and Control System	. Electro-pneumatic servo control system at each coupler.	254		
	. Electronic, solid state multiplexing sensing and control system (master system in locomotive and logic system in car).	452	450, 387	
	. Optional microwave receiving and control system in locomotive.	450		
ADAPTER TO MAKE COMPATIBLE WITH AAR TYPE "E" SYSTEM	. No additional adaptors required.	N/A		

electrical circuit utilize 50 to 100 circuits in the space which would be available. One of the compelling reasons for potential use of this candidate coupling system would be the desirability of having a large number of electrical circuits available for sensing and control functions.

The multiplexing control system, which uses binary logic pulses, can operate (in theory) with two circuits for total control of coupling sequences on a long train. One or two additional circuits are required to carry the nominal power needed in the use of the solid state electronic circuit modulars. In systems 1-3 and 2-2, this leaves only approximately two circuits available for sensing and other control systems; whereas, in system 3-2 there would be available from 40 to 90 other circuits for sensing or control uses.

The list of potential sensing circuits is nearly limitless (e.g., hot box detection, derailment detection, dragging brake, refrigeration temperature sensing). The easiest way of utilizing these sensing elements is to direct each through a separate circuit back to the locomotive control center. If such a technique is desired (due to its simplicity and low relative cost) a large number of circuits will be needed, and a system like 3-2 would be required. On the other hand, if sophisticated solid state electronic signal mixing and coding is used within each car logic system, a multiple of sensing inputs could be synthesized into one or two transmitting circuits. If this latter system were chosen (even with its greater complexity and cost), then a lesser number of electrical circuits would be required, and the circuit capability in Systems 1-3 or 2-2 would be adequate to perform all of the desired sensing and control functions. In this latter case, candidate coupling System 2-2 would appear more preferable than 3-2 because of its large gathering range capability, rugged construction, and (probable) lesser total cost than System 3-2.

5.4.2 Advantages and Disadvantages of Candidate Coupling Systems

Each of the three candidate coupling systems was developed to include concepts which would answer specific operating and safety problems outlined in the introduction of this report. Each system offers specific advantages and has some disadvantages.

System 1 has the primary advantage of being totally compatible with all freight cars currently in the U.S. rail-freight system. The basic concepts proposed in candidate system 1 include the distinct advantages of increased gathering range, knuckle open capability, and coupler entrapment and interlock features, thus overcoming the major mechanical deficiencies in the present Type "E" system. System Change 1-2 adds the automatic air connection and automatic brake valve control as a mechanical function of the coupling and uncoupling processes. These features overcome the most critical current safety problems arising from the necessity of trainman going between cars to complete the air connection system or to prepare cars for proper coupling. System Change 1-3 adds the capability of remote control by the additional electropneumatic and electronic control systems. This latter feature embodies the long-range potential for complete sensing and control of train operations from the locomotive or from some external control point. This system is limited to approximately 6 to 8 electrical circuits in the automatic electrical connector.

Candidate coupling system 2 embodies the best features of the semirigid coupler designs characterized in European operations. The primary advantage in this system is the very wide gathering range which it offers as well as a rugged and proven system. The basic system 2-1 includes an integral air connection coupling which is protected within the face of the gathering claws of the coupler. This protection feature is the best of the three systems in that it offers significant mechanical and environmental protection to the automatic air connection face. Since the automatic air connector unit represents a most significant and critical feature in the train operating sequence, candidate system 2 offers a particular and unique advantage in this respect. System Change 2-2 is limited similar to System Change 1-3 in the number of electrical contacts which can be readily added to the system for the final step involving electrical sensing and control circuits.

Candidate coupling System 3 contains the unique advantage of being a totally rigid system, which gives an exceptionally stable platform for attaching air or electrical connectors. This advantage is accompanied by the disadvantage of a heavy coupler unit, which requires a significant amount of machining to achieve the slack-free characteristic and which likewise requires a critical positioning control in order to prevent oblique coupling forces from damaging the coupler head faces. The primary advantages in this coupling system are its increased gathering range and capability of including a greater number of electrical circuits for sensing and control.

A complete listing of the comparative advantages of the three systems is given in Table 5-9. A similar listing of the primary disadvantages of the three systems is given in Table 5-10.

TABLE 5-9.-PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
I. IMPROVE TRAIN AIR LINE SYSTEM								
A. <u>Automatic Control</u>								
1) Automatic connection of air line and automatic opening of air valves at coupling:			X		X		X	
(a) Removes a safety hazard to crews by eliminating the need to go between cars (for regular coupling operations).			X		X		X	
(b) Speeds up the coupling operation.			X		X		X	
(c) Reduces train make-up time by permitting cars to be charged with air as they are coupled.			X		X		X	
(d) Causes no compromise of existing operating procedures.			X		X		X	
(e) Requires no special tools or devises to connect with nonequipped cars.			X		X		X	
(f) Operates regardless of brake system phase of either car.			X		X		X	
2) *Automatic operation of air valves at uncoupling (intentional - close valves; unintentional - open valves instantly):*			X		X		X	
(a) Removes a safety hazard to crews by eliminating a need to go between cars to close angle cocks before uncoupling.			X		X		X	
(b) Speeds up uncoupling operation.			X		X		X	
(c) Permits normal emergency brake application at unintentional uncoupling.			X		X		X	
(d) Operates regardless of brake system phase of either car.			X		X		X	
(e) System is fail safe (go to emergency brake mode).			X		X		X	

TABLE 5-9.-PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
I. IMPROVE TRAIN AIR LINE SYSTEM (CONTINUED)								
B. Improved Performance								
1) Automatic connection of air lines offers:								
(a) Greater hose life and absence of broken train pipes resulting from air hose uncoupling forces.			X		X		X	
(b) Significant improvement in integrity of train line connections.			X		X		X	
(c) Reduced air leakage (at all temperatures) due to a positive pressure seal.			X		X		X	
2) Sealing gaskets are readily removable from rear for reduced maintenance.					X			
C. General Design of Air Connection System								
1) Spread-wing air connector design allows potential for later design changes to modify gathering range while retaining compatibility with units already in use.			X					
(a) Offers potential for adding other remote control functions.			X		X		X	
(b) Permits equipped and nonequipped cars to be operated together without need of interchange devices.			X					
(c) Can be applied to existing cars on an incremental basis with minimum interruption of normal service.			X					
(d) Can withstand the extremes of railroad operating environment.			X		X		X	
(e) Can be readily adapted to carry an additional train air line or electric train line.			X		X		X	

TABLE 5-9.-PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
II. IMPROVE MECHANICAL COUPLING								
A. General Design								
1) "Rigid" and "semi-rigid" design allows integrally connected air and electrical connectors without separate gathering capabilities.					X		X	
2) Compatible with type "E" system (without use of adapters).	X	X						
3) Requires no manual preparation to couple.	X	X			X		X	
4) Entire coupling system operates mechanically and is thus minimally affected by temperature changes or environmental wear.	X							
5) Removal of the "knuckle open" device (for possible repair) does not render the coupler inoperative.	X	X						
6) Coupler head design offers good mechanical protection of air and electrical connectors.					X			
7) Embodies highest strength/weight ratio due to single cast head design and direct pulling force on centerline of coupler.					X			
B. Automatic Engagement								
1) Improvement in lateral and vertical gathering ranges.	X	X						
(a) Nominal (1.5 to 2.0 x standard).	X	X						
(b) Good (2.5 to 3.5 x standard).							X	
(c) Significant (over 3.5 x standard).					X			

TABLE 5-9.-PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
II. IMPROVE MECHANICAL COUPLING (CONTINUED)								
B. Automatic Engagement (Continued)								
2) Improvement in positive locking:								
(a) Nominal (positive rotation of lockset by force of mating coupler).	X	X						
(b) Good (spring loaded coupling hook and locking pawl).					X			
(c) Significant (spring loaded coupling hook and direct locking catch forced by coupler guide pin).							X	
C. Positive Retainment								
1) Coupling at wider speed range.								
(a) Nominal (mechanical forced rotation of lockset).	X	X						
(b) Good (spring loaded locking hook).					X		X	
2) Reduced free slack;								
(a) Nominal (0.8 x standard).	X							
(b) Good (0.4 x standard).		X			X			
(c) Significant ("zero" free slack nominal).							X	
3) Vertical interlock and coupler entrapment:								
(a) Nominal (limited vertical movement to prevent slipover).	X							
(b) Good (interlocking gathering arms - acceptable for long cars).		X			X			
(c) Significant (interlocking hooks and pin/dowel interlock).							X	

TABLE 5-9.-PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
II. IMPROVE MECHANICAL COUPLING (CONTINUED)								
D. Location Control								
1) Coupler location control:								
(a) Centering from draft gear force to within 2" (short cars only).	X							
(b) Centering from spring force to within 1.2" (long and short cars).					X			
(c) Positioning to within 7" of track center (long cars).		X					X	
2) Reduced contour angling from interlocking coupler heads.		X			X		X	
E. Reduced Maintenance								
1) Slack free design offers better resistance of coupler system to damage from coupling shock and operating vibrations.							X	
2) Major force requirements are accomplished by pneumatic devices to provide a common maintenance skill demand (i.e., no electro-mechanical relays or solenoids to compound maintenance skills).			X	X	X	X	X	X
3) Major electro-pneumatic control devices are contained in environmentally protected housings.								
4) Lubrication fittings at coupler head and shank wear points.	X	X			X		X	

TABLE 5-9.--PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
III. IMPROVE MECHANICAL UNCOUPLING								
A. Uncoupling Capability								
1) System can provide an alternate side lever (but is not needed).	X	X			X		X	
2) System offers push button uncoupling release from side of car.			X		X		X	
3) System provides for automatic remote release from within train.				X		X		X
4) Uncoupling capability under nominal (less than 8,000 lbs.) draft force through the use wedge or rotating leveraging of unlocking mechanism.					X		X	
5) Manual uncoupling (through operation of uncoupling rigging) is possible regardless of availability of air or electrical power.								
B. Recoupling Capability								
1) Uncoupling system sets or locks the "knuckle" open for automatic recoupling capability.	X	X			X		X	
2) Provision to manually lock open the locking mechanism to prevent automatic recoupling.					X			
IV. IMPROVE GENERAL SYSTEMS								
A. Brake Control								
1) System provides time delay set provisions for applying brakes (to the cut car or cars) under intentional uncoupling conditions.				X		X		X
2) System provides for emergency set of brakes under unintentional uncoupling conditions.			X		X		X	

TABLE 5-9.--PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
IV. IMPROVE GENERAL SYSTEMS (CONTINUED)								
B. Electrical Train Line System								
1) Provides for automatic connection make and break between cars.				X		X		X
(a) Electrical contact principal is well understood and should present no major problem in instruction of maintenance personnel.				X		X		X
(b) Contactors are held in position by gathering action of air connector.				X				
(c) Contactors are held in position by locking action of coupler heads.						X		X
2) Provides for multiple circuit capacities.								
(a) Six-eight circuits capability (including two redundant power circuits, and one or two train sensing circuits).				X		X		
(b) Fifty-one hundred circuits capability (including multiple power circuits and unlimited train sensing circuits).								X
(c) Good electrical contact assured through the use of butt faced, silver tipped, individually spring loaded rotating contacts.				X		X		X
(d) Long life contacts are assured by multiplexing signals of low power demand from solid state electrical control circuits.				X		X		X

TABLE 5-9.-PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
IV. IMPROVE GENERAL SYSTEMS (CONTINUED)								
B. Electric Train Line System (Continued)								
3) Provides for automatic sequencing of contactors.								
(a) All switching of electrical power is accomplished by master control after contact has been completed - thus no arcing of contacts.				X		X		X
(b) No exposure of "live" electrical contacts is uncoupled condition - thus no causing a safety hazard.				X		X		X
(c) Contactor block is moved forward into contact by pneumatic cylinder after mechanical coupling is complete (and environmental cover is pneumatically moved aside).				X		X		X
(d) Mechanical (hand) back-up of contactor engagement is provided.				X		X		X
4) Provides for environment protection of contactors by:								
(a) Cover over contactors when uncoupled.				X		X		X
(b) Electrical insulation between contactors and cover.				X		X		X
(c) Cover moved aside pneumatically after mechanical coupling is complete.				X		X		X
(d) Contactor block has a compressible seal around outside edges to protect the mated contacts from environment.				X		X		X
(e) Coupler head design offers physical protection of electrical contactor prior to coupling.								

TABLE 5-9.-PRIMARY ADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
IV. IMPROVE GENERAL SYSTEMS (CONTINUED)								
B. <u>Electric Train Line System (Continued)</u>								
5) Provides for a sensing and control system having functional units consisting of:								
(a) An electro-pneumatic servo system is a sealed unit located at each coupler (to transmit low power electronic signals to pneumatic force actuators).				X		X		X
(b) A multiplexing master system (solid state electronic) can be located at any position in train and could negate the need for a caboose in some operating situations.				X		X		X
(c) An electronic logic and sensing unit is located in each car.				X		X		X
6) Specific features of the electronic control system include:								
(a) Use of proven solid state electronic principles.				X		X		X
(b) Components are housed in sealed units.				X		X		X
(c) Modular electronic units are readily maintained and replaceable.				X		X		X
(d) Solid state electronic units are insensitive to mechanical environment.				X		X		X
(e) Electronic control is not dependent on transmission of large electrical power signals and therefore is not susceptible to malfunction due to poor grounding through the train wheels.				X		X		X
7) Electro-pneumatic control system combines the versatility of low power electronic controls with pneumatic power for performing operating functions.				X		X		X

TABLE 5-10.-PRIMARY DISADVANTAGES OF

OPERATIONAL CHARACTERISTICS

I. IMPROVE TRAIN AIR LINE SYSTEM

A. Automatic Air Connection

1) Air line automatic connection system is susceptible to ice and snow build-up in face of system - this problem is somewhat alleviated by:

(a) Gathering wings tend to scrap of build-up at coupling.

(b) Location of air seal is protected within coupler head.

2) Proper operation of integral air (and electrical) connector systems are dependent on maintaining a limited free slack - this will require added maintenance (and cost) to inspect critical slack dimensions.

II. IMPROVE MECHANICAL COUPLING

A. General Design

1) Not compatible with free knuckle type "E" couplers without adapters.

2) Coupler design relies on close machined tolerances for slack - free fit - therefore requires more machining - higher cost.

3) Due to possible motion between mated couplers, a separate structure is required to attach (and gather) air or electric connectors.

4) Shank of type "F" coupler subject to fatigue and cracking at the pin connection location ("blind" to visual inspection).

CANDIDATE COUPLING SYSTEMS

COMPATIBLE				NONCOMPATIBLE			
SYSTEM 1				SYSTEM 2		SYSTEM 3	
"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
		X		X		X	
		X					
				X			
				X	X	X	X
				X		X	
						X	
X							
	X						

TABLE 5-10.-PRIMARY DISADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
II. IMPROVE MECHANICAL COUPLING (CONTINUED)								
A. General Design (Continued)								
5) Lower shelf on type "E" coupler results in a lower position of the air/electrical unit than is desired for damage susceptibility from road debris.	X							
6) Coupler head design does not offer any significant mechanical protection for air seals or electrical connectors.	X	X					X	
7) Coupler embodies a discontinuous coupling movement which could cause an accelerated wear on lateral moving members.					X			
8) Coupler does not provide adequate interlock as required for long cars.	X							
9) Flat face "rigid" coupler design requires a positioning device to prevent excessive damage to coupler head and aligning pins from coupling at oblique angles.							X	
III. IMPROVE MECHANICAL UNCOUPLING								
A. General Design								
1) Remote pneumatic uncoupling is susceptible to possible malfunction due to the excessive force required to operate frozen or stuck uncoupling rigging.			X	X	X	X	X	X
B. Uncoupling Capability								
1) A side-of-car push button uncoupling capability is subject to potential vandalism and undesired uncoupling.			X		X		X	

TABLE 5-10.-PRIMARY DISADVANTAGES OF CANDIDATE COUPLING SYSTEMS (CONTINUED)

OPERATIONAL CHARACTERISTICS	COMPATIBLE				NONCOMPATIBLE			
	SYSTEM 1				SYSTEM 2		SYSTEM 3	
	"FREE" KNUCKLE				"SEMI-RIGID," SPREAD CLAW, HINGED HOOK		"RIGID," FLAT FACE, HINGED HOOK	
	BASIC SYSTEM 1-1A	BASIC SYSTEM 1-1B	SYSTEM CHANGE 1-2	SYSTEM CHANGE 1-3	BASIC SYSTEM 2-1	SYSTEM CHANGE 2-2	BASIC SYSTEM 3-1	SYSTEM CHANGE 3-2
IV. IMPROVE GENERAL SYSTEMS								
A. Electrical Train Line System								
1) The addition of an electric system adds the requirement for another skill to maintenance requirements.				X		X		X
(a) An inter-car contact system requires periodic cleaning and maintenance (i.e., more frequent than current coupling systems).				X		X		X
(b) An electric contact system is subject to damage and malfunction of the intended sensing and control functions.				X		X		X
(c) The control system is subject to tampering.				X		X		X
(d) The contact system is subject to vandalism.				X		X		X
(e) No data is available concerning the expected lifetime of this type of contact system under full rail freight service.				X		X		X
2) The number of electrical circuits is limited (6-8 circuits) and this potentially limits the number of sensing circuits.				X		X		
B. Sensing and Control System								
1) Proper operation of the control system is dependent on reliable inter-car contacts.				X		X		X
2) All pneumatic valving and mechanical operating units (pistons, etc.) must be protected from clogging by an effective filter system.			X	X	X	X	X	X

6. PRELIMINARY COSTING

6.1 INTRODUCTION

Each of the Candidate Coupling Systems defined in Section 5 was subject to a preliminary engineering evaluation as relating to costing. This evaluation was directed at determination of a reasonable estimate for the cost of each of the separate subsystem elements.

The preliminary costs for each system's elements were derived by using a combination of the following inputs:

1) Review of technical literature for past cost estimates.

2) Discussions with railroad industry suppliers and users for verification of concept production potentials.

3) Preliminary engineering evaluation of complexity of new concepts as compared with the basic type "E" system.

4) Evaluation of present costing as a function of the complexity of concept design and relative quantities produced.

5) Engineering estimate of potential replacement life of new concepts as compared to reported field problems with similar systems.

6.2 GENERAL LIMITATIONS

Several assumptions were made for both technical and cost aspects as applicable to the various subsystem elements. These assumptions were made to define more adequately or constrain the possible variations in the preliminary cost estimates. These constraints are shown on the following page.

6.2.1 Cost Constraints

1) All costs are based on constant 1975 dollars and include an estimate of the total of labor and material costs.

2) Projections of costs assume that full quantity production would be made at a level of at least 50,000 car sets per year.

3) Costs are estimated as an "order of merit" based on a preliminary understanding of the potential for a final design. As such, the cost estimates are believed consistent in the costing approach but should be considered to have an uncertainty level for any specific item of $\pm$ 25 percent.

4) No calculation was made for estimated inventory costs, since these are subject to unique control by each railroad.

5) Annual maintenance and replacement costs were estimated on the basis of the estimated replacement life of each listed equipment item including estimated replacement labor and upkeep labor.

6) No costs were included for preparation or repair of old cars prior to installation of the new coupler system (or subsystem). It is assumed that all cars to be modified would be in a state of full repair at the time of coupler modifications.

Significant design work has been accomplished by European railroads to determine the potential costs for both car preparation and coupler changeover. Concept 49 included an estimate of approximately $1100 for the average cost of preparation of old cars to insure an adequate anchoring and sill strength for mounting of new center-buffer coupler units. No technical data were available to allow a reasonable basis for estimating a comparable preparation cost for an "average" U.S. rail car.

7) It is assumed that an average of one Interchange Adapter

unit would be required for each car with a System 2 or 3 coupler.

8) Initial system costs for a new car system are estimated as additional to the cost for the basic car equipped with the standard coupler and draft gear system. If the new system element is not estimated to increase the cost over the basic car system, this estimate is indicated by a "N.I." notation (for NO INCREASE).

9) Initial system costs for modified cars are estimated as an addition to the cost for a new basic coupler and draft gear system.

10) No cost estimate is included for value of the revenue time loss by each car during the coupler modification program.

11) No costs are included for any peripheral safety or back-up equipment which might be designated by AAR or Governmental agencies as required to be used in conjunction with any new coupler system.

6.2.2 Technical Constraints

1) It is assumed that the maximum utilization would be made of casting as opposed to welding or machining. In particular, this applies to shelves or guard-arm extensions, which are assumed to be manufactured as a one-piece casting as compared to weldment additions to the basic coupler heads.

2) Grade "C" steel is assumed as the standard for coupler castings.

3) It is assumed that the AAR rules would be modified to allow tapping into the main air system to attain pressure for operation of valves and force boosting of uncoupling and valve operation. Cost estimates have been included in subsystems 1-2, 2-1, and 3-1 for the check valves and holding reservoirs necessary to safely accomplish this operation.

6.3 PRELIMINARY COST ESTIMATES

Included as Tables 6-1 through 6-8 are the individual preliminary cost estimates for each of the separate candidate coupler subsystems. The format for the presentation of the preliminary cost estimates for the three candidate systems is as follows:

1) Compatible System #1
   (a) Basic System 1-1A, Short Car (Table 6-1)
   (b) Basic System 1-1B, Long Car (Table 6-2)
   (c) System Change 1-2, Addition of Air Connector and Valve Control System (Table 6-3)
   (d) System Change 1-3, Addition of Electropneumatic Control Systems (Table 6-4)
2) Noncompatible System #2, Semirigid, Spread-Claw
   (a) Basic System 2-1, (Table 6-5)
   (b) System Change 2-2, Addition of Electropneumatic Control Systems (Table 6-6)
3) Noncompatible System #3, Rigid, Flat-Faced
   (a) Basic System 3-1, (Table 6-7)
   (b) System Change 3-2, Addition of Electropneumatic Control Systems (Table 6-8)

Each of these tables include the following information about each subsystem:

1) Concept number
2) Concept indentification
3) Preliminary cost estimates for:
   (a) Initial system cost - with new car
   (b) Initial system cost - modify old car
   (c) Continuing annual estimated maintenance and replacement cost.

TABLE 6-1.-PRELIMINARY COST ESTIMATE FOR CANDIDATE COUPLING SYSTEM 1-1A

CONCEPT NUMBER	CONCEPT IDENTIFICATION	COST ESTIMATES(1) PER CAR SYSTEM			REMARKS (ESTIMATED AVERAGE REPLACEMENT LIFE)
		INITIAL SYSTEM COSTS		CONTINUING ANNUAL ESTIMATED MAINTENANCE AND REPLACEMENT COST DOLLARS(4)	
		WITH NEW CAR DOLLARS(2)	MODIFY OLD CAR DOLLARS(3)		
501	Coupler knuckle contour change and revised front knuckle shape.	N.I.(5)	N.I.	N.I.	(Same as "E")
702	Guard arm extension faces on top and bottom shelves (in addition to Concept 54).	10	10	N.I.	(Same as "E")
502b	Compatimatic* coupler head.	90	90	20	(Six years for locking hardware)
	(Revised operating rod.)	10	60	N.I.	(Same as "E")
54	Top and bottom coupler shelf.	50	50	N.I.	(Same as "E")
26	Self centering draft gear.	10	10	N.I.	(Same as "E")
503a	Lubrication fittings.	50	50	20	(Maintenance at six-month intervals)
54	Blunt and round front edges of coupler and shelves.	N.I.	N.I.	N.I.	(Same as "E")
	Total cost estimates(1) per car:				
	Basic system equipment	220	270	40	
	Installation	-	-	-	
	Total costs	220	270	40	

Notes:
(1) All costs are estimated based on constant 1975 dollars.
(2) All costs are in addition to the costs for the basic short car with the complete type "E" basic coupler and draft gear system.
(3) Installation of system 1-1A onto an existing short car would include the installed cost for a basic type "E" coupler and draft gear system in addition to this system cost.
(4) These maintenance and replacement cost estimates are in addition to the basic costs for the type "E" system.
(5) No increase.
(*) Developed by National Castings Division, Midland Ross Corporation.

TABLE 6-2.-PRELIMINARY COST ESTIMATE

CONCEPT NUMBER	CONCEPT IDENTIFICATION
501	Coupler knuckle contour change and revised front knuckle shape.
428b	Type "F" interlocking coupler head.
502b	Compatimatic* coupler head.
	(Revised operating rod.)
52	Top coupler shelf.
31b	Coupler positioning device (hydraulic).
25	Vertical spring carrier system
503a	Lubrication fittings
52	Blunt and round front edges of coupler, top shelf and guard arm/pocket.
	Total cost estimates(1) per car:
	Basic system equipment
	Installation
	Total costs

Notes:
(1) All costs are estimated based on constant 1975 dollars.
(2) All costs are in addition to the costs for the basic long car with the complete type "F" basic coupler and draft gear system.
(3) Installation of system 1-1B onto an existing long car would include the installed cost for a basic type "F" coupler and draft gear system in addition to this system cost.
(4) These maintenance and replacement cost estimates are in addition to the basic costs for the type "F" system.
(5) No increase.
(*) Developed by National Castings Division, Midland Ross Corporation.

FOR CANDIDATE COUPLING SYSTEM 1-1B

COST ESTIMATES(1) PER CAR SYSTEM			REMARKS (ESTIMATED AVERAGE REPLACEMENT LIFE)
INITIAL SYSTEM COSTS		CONTINUING ANNUAL ESTIMATED MAINTENANCE AND REPLACEMENT COST DOLLARS(4)	
WITH NEW CAR DOLLARS(2)	MODIFY OLD CAR DOLLARS(3)		
N.I.(5)	N.I.	N.I.	(Same as "F"
Basic System	Basic System	N.I.	(Same as "F")
100	100	20	(Six years for locking hardware)
10	60	N.I.	(Same as "F")
40	40	N.I.	(Same as "F")
2,000	2,000	200	Wide mouth bell housing assumed as part of long car (estimate 12 years)
120	120	30	(Estimate six years)
50	50	20	(Maintenance at six-month intervals)
N.I.	N.I.	N.I.	(Same as "F")
2,320	2,370	270	
250	450	-	
2,570	2,820	270	

TABLE 6-3.-PRELIMINARY COST ESTIMATE

CONCEPT NUMBER	CONCEPT IDENTIFICATION
22	Automatic air connection.
22	Automatic air valve control (mechanical).
674	Remote uncoupling button at side of car.
943	Pneumatic uncoupling operating mechanism.
22	Air hose/glad hand connection (relocated).
-	Air control system (tap off air brake line).
	Total cost estimates(1) per car:
	Basic system equipment
	Installation
	Total costs
	Notes: (1) All costs are estimated based on constant 1975 dollars.
	(2) All costs are in addition to the basic uncoupling and air system equipment standard on all cars, (and assumed to be in place and operable).
	(3) These maintenance and replacement cost estimates are offset by savings from the normal air and uncoupling system upkeep.
	(4) No increase.

FOR CANDIDATE COUPLING SYSTEM 1-2

COST ESTIMATES(1) PER CAR SYSTEM			
INITIAL SYSTEM COSTS		CONTINUING ANNUAL ESTIMATED MAINTENANCE AND REPLACEMENT COST DOLLARS(3)	REMARKS (ESTIMATED AVERAGE REPLACEMENT LIFE)
WITH NEW CAR DOLLARS(2)	MODIFY OLD CAR DOLLARS(2)		
300	300	85	(Estimate six years)
600	600	70	(Estimate ten years)
40	40	10	(Estimate ten years)
200	200	30	(Estimate ten years)
50	50	N.I.(4)	(Estimate five years)
300	300	35	(Estimate 20 years)
1,490	1,490	230	
500	1,000	-	
1,990	2,490	230	

TABLE 6-4.-PRELIMINARY COST ESTIMATE FOR CANDIDATE COUPLING SYSTEM 1-3

CONCEPT NUMBER	CONCEPT IDENTIFICATION	COST ESTIMATES(1) PER CAR SYSTEM			REMARKS (ESTIMATED AVERAGE REPLACEMENT LIFE)
		INITIAL SYSTEM COSTS		CONTINUING ANNUAL ESTIMATED MAINTENANCE AND REPLACEMENT COST DOLLARS(4)	
		WITH NEW CAR DOLLARS(2)	MODIFY OLD CAR DOLLARS(3)		
254	Electro-pneumatic servo control system at each coupler.	1,600(4)	1,600(4)	200(5)	(Estimate ten years)
1200 450a 516b 254 516b	Electrical connector system (attached to air connector) with: Six-eight butt face, spring loaded, rotating contacts. Silver plated contacts and mechanical back-up. Maintenance removal potential. Environmental sealing gasket.				(Estimate four years)
1200	Air piston sequencing of contactors after mating.	200	200	30	(Estimate ten years)
301b 36 516b	Environmental cover opened pneumatically after mating, with: Nylon hinges. Plastic cover insulators.	400	400	275	(Estimate two years)
452	Electronic, solid state multiplexing sensing and control system.	1,500	1,500	275	(Estimate six-eight years)
	Intra-car electrical conduit system	125	125	5	(Estimate 20 years)
	Total cost estimates(1) per car: Basic system equipment Installation	 4,225 575	 4,225 1,150	 910 -	
	Total costs	4,800	5,375	910	

Notes:
(1) All costs are estimated based on constant 1975 dollars.
(2) All costs are in addition to the basic uncoupling and air system equipment standard on all cars, (and assumed to be in place and operable).
(3) These maintenance and replacement cost estimates are offset by savings from the normal air and uncoupling system upkeep.
(4) Electro-pneumatic control system would replace mechanical air valve control and save $600 in system 1-2.
(5) Electro-pneumatic control system would replace mechanical air valve control and save $70 in system 1-2.

TABLE 6-5.-PRELIMINARY COST ESTIMATE

CONCEPT NUMBER	*CONCEPT IDENTIFICATION*
309	Basic semirigid, spread claw coupler system with draft gear and uncoupling levers.
503a	Integral air connection system within coupler with:
45a	Double concentric compressible rubber seals.
309	Pivoted rear removal of air connection assembly.
22	Automatic air valve control (mechanical).
318	O.R.E.II cross beam centering device with:
25	Vertical spring carrier system.
-	Air control system (tap off air brake line).
503a	Lubrication fittings
674	Remote uncoupling button at side of car.
391	Air cylinder release of locking block.
22	Air hose/glad hand connection (relocate).
301a	Coupler head interchange adapter (assume one/car)
	Total cost estimates(1) per car:
	Basic system equipment
	Installation
	Total costs
	Notes: (1) All costs are estimated based on constant 1975 dollars. (2) All costs are in addition to the costs for a basic car system including the standard type "E" coupler and draft gear system (including wide mouth bell housings as required for long cars). (3) These maintenance and replacement cost estimates are in addition to the basic costs for the type "E" coupler system but are offset by savings from the normal air and uncoupling system upkeep. (4) No increase.

FOR CANDIDATE COUPLING SYSTEM 2-1

COST ESTIMATES(1) PER CAR SYSTEM			
INITIAL SYSTEM COSTS		CONTINUING ANNUAL ESTIMATED MAINTENANCE AND REPLACEMENT COST DOLLARS(3)	REMARKS (ESTIMATED AVERAGE REPLACEMENT LIFE)
WITH NEW CAR DOLLARS(2)	MODIFY OLD CAR DOLLARS(2)		
40	40	20	(Estimate six years for locking hardware, remainder same as "E")
150	150	30	(Estimate eight years)
600	600	60	(Estimate 12 years)
120	120	30	(Estimate six years)
300	300	35	(Estimate 20 years)
50	50	20	(Maintenance at six-month intervals)
40	40	10	(Estimate ten years)
200	200	30	(Estimate ten years)
50	50	N.I.(4)	(Same as "E")
250	250	10	(Six years for locking hardware, remainder same as "E")
1,800	1,800	245	
465	930	-	
2,265	2,730	245	

TABLE 6-6.-PRELIMINARY COST ESTIMATE FOR CANDIDATE COUPLING SYSTEM 2-2

CONCEPT NUMBER	CONCEPT IDENTIFICATION	COST ESTIMATES(1) PER CAR SYSTEM — INITIAL SYSTEM COSTS — WITH NEW CAR DOLLARS(2)	INITIAL SYSTEM COSTS — MODIFY OLD CAR DOLLARS(2)	CONTINUING ANNUAL ESTIMATED MAINTENANCE AND REPLACEMENT COST DOLLARS(3)	REMARKS (ESTIMATED AVERAGE REPLACEMENT LIFE)
254	Electro-pneumatic servo control system at each coupler.	1,600(4)	1,600(4)	200(5)	(Estimate ten years)
36	Electrical connector system integral (located within coupler head) with:	500	500	100	(Estimate six years)
450a	Six-eight butt face, spring loaded, rotating contacts.				
516b	Silver-plated contacts and mechanical back-up.				
309	Maintenance removal potential.				
516b	Environmental sealing gasket.				
1200	Air piston sequencing of contactors after mating.	200	200	30	(Estimate ten years)
301b	Environmental cover removed pneumatically after mating, with:	400	400	140	(Estimate four years)
36	Nylon hinges.				
516b	Plastic cover insulators.				
452	Electronic, solid state, multiplexing sensing and control system.	1,500	1,500	275	(Estimate six-eight years)
-	Intra-car electrical conduit system.	125	125	5	(Estimate 20 years)
	Total cost estimates(1) per car:				
	Basic system equipment	4,325	4,325	750	
	Installation	575	1,150	-	
	Total costs	4,900	5,475	750	

Notes:
(1) All costs are estimated based on constant 1975 dollars.
(2) All costs are in addition to the costs for a basic car system including the standard type "E" coupler and draft gear system (including wide mouth bell housings as required for long cars).
(3) These maintenance and replacement cost estimates are in addition to the basic costs for the type "E" coupler system but are offset by savings from the normal air and uncoupling system upkeep.
(4) Electro-pneumatic control system would replace mechanical air valve control and save $600 in system 2-1.
(5) Electro-pneumatic control system would replace mechanical air valve control and save $60 in system 2-1.

TABLE 6-7.-PRELIMINARY COST ESTIMATE

CONCEPT NUMBER	CONCEPT IDENTIFICATION
9	Basic rigid, flat face, hinged hook coupler system with draft gear and uncoupling levers.
9	Integral air connection system
22	Automatic air valve control (mechanical).
31b	Coupler positioning device (hydraulic).
25	Vertical spring carrier system.
503a	Lubrication fittings
-	Air control system (tap off air brake line).
674	Remote uncoupling button at side of car.
391	Air cylinder release of locking block.
22	Air hose/glad hand connection (relocate).
9	Coupler head interchange adapter (assume one/car).
	Total cost estimates(1) per car:
	Basic system equipment
	Installation
	Total costs
	Notes: (1) All costs are estimated based on constant 1975 dollars. (2) All costs are in addition to the costs for a basic car system including the standard type "E" coupler and draft gear system (including wide mouth bell housings as required for long cars). (3) These maintenance and replacement cost estimates are in addition to the basic costs for the type "E" coupler system but are offset by savings from the normal air and uncoupling system upkeep. (4) No increase.

FOR CANDIDATE COUPLING SYSTEM 3-1

COST ESTIMATES(1) PER CAR SYSTEM			
INITIAL SYSTEM COSTS		CONTINUING ANNUAL ESTIMATED MAINTENANCE AND REPLACEMENT COST DOLLARS(3)	REMARKS (ESTIMATED AVERAGE REPLACEMENT LIFE)
WITH NEW CAR DOLLARS(2)	MODIFY OLD CAR DOLLARS(2)		
285	285	40	(Estimate six years for locking hardware, remainder same as "E")
100	100	25	(Estimate eight years)
600	600	60	(Estimate 12 years)
2,000	2,000	200	(Estimate 12 years)
120	120	30	(Estimate six years)
50	50	20	(Maintenance at six-month intervals)
300	300	35	(Estimate 20 years)
40	40	10	(Estimate ten years)
200	200	30	(Estimate ten years)
50	50	N.I.(4)	(Same as "E")
250	250	10	(Six year estimate for locking hardware, remainder same as "E")
3,995	3,995	460	
465	935	-	
4,460	4,930	460	

TABLE 6-8.-PRELIMINARY COST ESTIMATE FOR CANDIDATE COUPLING SYSTEM 3-2

CONCEPT NUMBER	CONCEPT IDENTIFICATION	COST ESTIMATES(1) PER CAR SYSTEM: INITIAL SYSTEM COSTS			REMARKS (ESTIMATED AVERAGE REPLACEMENT LIFE)
		WITH NEW CAR DOLLARS(2)	MODIFY OLD CAR DOLLARS(2)	CONTINUING ANNUAL ESTIMATED MAINTENANCE AND REPLACEMENT COST DOLLARS(3)	
254	Electro-pneumatic servo control system at each coupler.	1,600(4)	1,600(4)	200(5)	(Estimate ten years)
9	Electrical connector system integral (located below coupler head) with:	1,000	1,000	300	(Estimate four years)
450a	50-100 butt face, spring loaded, rotating contacts.				
516a	Silver-plated contacts and mechanical back-up.				
254	Maintenance removal potential.				
516b	Environmental sealing gasket.				
254	Air piston sequencing of contactors after mating.	200	200	30	(Estimate ten years)
301b	Environmental cover removed pneumatically after mating, with:	500	500	235	(Estimate three years)
36	Nylon hinges				
516b	Plastic cover insulators.				
452	Electronic, solid state, multiplexing sensing and control system.	1,500	1,500	275	(Estimate six-eight years)
-	Intra-car electrical conduit system.	125	125	5	(Estimate 20 years)
	Total cost estimates(1) per car:				
	Basic system equipment	4,925	4,925	1,045	
	Installation	650	1,300	-	
	Total costs	5,575	6,225	1,045	

Notes:
(1) All costs are estimated based on constant 1975 dollars.
(2) All costs are in addition to the costs for a basic car system including the standard type "E" coupler and draft gear system (including wide mouth bell housings as required for long cars).
(3) These maintenance and replacement cost estimates are in addition to the basic costs for the type "E" coupler system but are offset by savings from the normal air and uncoupling system upkeep.
(4) Electro-pneumatic control system would replace mechanical air valve control and save $600 in system 3-1.
(5) Electro-pneumatic control system would replace mechanical air valve control and save $60 in system 3-1.

4) Remarks (estimated average replacement life)

The cost data from these eight tables are summarized in Tables 6-9 through 6-11. These tables list a summary of the three cost estimates for each of the three Candidate Coupling Systems as applicable to an "average" car. These system cost summaries are compared by the cumulative increasing costs associated with increasing automation and greater improvements brought about by three primary subsystem groupings. These groupings are:

1) Improvements in mechanical coupling and uncoupling.

2) Improvements for automatic air connection and valve control.

3) Improvements for full electropneumatic control.

TABLE 6-9.-SUMMARY OF COST ESTIMATES(1) FOR CANDIDATE COUPLING SYSTEMS INSTALLED ON AN "AVERAGE"(2) NEW CAR

PRIMARY IMPROVEMENTS ACCOMPLISHED BY CANDIDATE COUPLING SYSTEMS	SYSTEM 1 - TOTALLY COMPATIBLE WITH "E" SYSTEM		SYSTEM 2 - NONCOMPATIBLE SEMIRIGID, SPREAD CLAW SYSTEM		SYSTEM 3 - NONCOMPATIBLE RIGID, FLAT FACED SYSTEM	
	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)
1. Mechanical Coupling and Uncoupling: Increase Gathering Range "Knuckle" Always Open Coupler Interlock and Entrapment Centering/Positioning of Coupler Reduced Free Slack	338	-	1 and 2 are combined into one system	-	1 and 2 are combined into one system	-
2. Automatic Air Connection and Valve Control: Automatic Air Connection with Coupling Automatic Mechanical Air Valve Operation Push Button Uncoupling from Side of Car Automatic Train Brake Control at Uncoupling	1,990	2,328	2,265	2,265	4,460	4,460
3. Full Electro-Pneumatic Control: Automatic Disengagement of Positioning at Coupling Remote Uncoupling Capability Time Delay Brake Setting at Uncoupling Automatic Electrical Connection at Coupling Train Condition Sensing Capability Multiplexing Control from Locomotive	4,800	6,528	4,900	6,565	5,575	9,435

Notes: (1) All costs are estimated based on constant 1975 dollars.
(2) "Average" car assumes a mix of 95% short cars and 5% long cars.
(3) Cumulative system costs assume that all modifications would be done simultaneously and include reductions for some redundant subsystems.

TABLE 6-10.-SUMMARY OF COST ESTIMATES(1) FOR CANDIDATE COUPLING SYSTEMS INSTALLED AS A MODIFICATION TO AN "AVERAGE"(2) CAR

PRIMARY IMPROVEMENTS ACCOMPLISHED BY CANDIDATE COUPLING SYSTEMS	SYSTEM 1 - TOTALLY COMPATIBLE WITH "E" SYSTEM		SYSTEM 2 - NONCOMPATIBLE SEMIRIGID, SPREAD CLAW SYSTEM		SYSTEM 3 - NONCOMPATIBLE RIGID, FLAT FACED SYSTEM	
	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)
1. Mechanical Coupling and Uncoupling: Increase Gathering Range "Knuckle" Always Open Coupler Interlock and Entrapment Centering/Positioning of Coupler Reduced Free Slack	398	-	1 and 2 are combined into one system	-	1 and 2 are combined into one system	-
2. Automatic Air Connection and Valve Control: Automatic Air Connection with Coupling Automatic Mechanical Air Valve Operation Push Button Uncoupling from Side of Car Automatic Train Brake Control at Uncoupling	2,490	2,888	2,730	2,730	4,930	4,930
3. Full Electro-Pneumatic Control: Automatic Disengagement of Positioning at Coupling Remote Uncoupling Capability Time Delay Brake Setting at Uncoupling Automatic Electrical Connection at Coupling Train Condition Sensing Capability Multiplexing Control from Locomotive	5,375	7,663	5,475	7,605	6,225	10,555

Notes: (1) All costs are estimated based on constant 1975 dollars.
(2) "Average" car assumes a mix of 95% short cars and 5% long cars.
(3) Cumulative system costs assume that all modifications would be done simultaneously and include reductions for some redundant subsystems.

TABLE 6-11.-SUMMARY OF COST ESTIMATES(1) FOR CONTINUING ANNUAL MAINTENANCE OF CANDIDATE COUPLING SYSTEMS INSTALLED ON AN "AVERAGE"(2) CAR

PRIMARY IMPROVEMENTS ACCOMPLISHED BY CANDIDATE COUPLING SYSTEMS	SYSTEM 1 - TOTALLY COMPATIBLE WITH "E" SYSTEM		SYSTEM 2 - NONCOMPATIBLE SEMIRIGID, SPREAD CLAW SYSTEM		SYSTEM 3 - NONCOMPATIBLE RIGID, FLAT FACED SYSTEM	
	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)	SUBSYSTEM COST, DOLLARS(1)	CUMULATIVE SYSTEM COST, DOLLARS(1)(3)
1. Mechanical Coupling and Uncoupling: Increase Gathering Range "Knuckle" Always Open Coupler Interlock and Entrapment Centering/Positioning of Coupler Reduced Free Slack	52	-	1 and 2 are combined into one system	-	1 and 2 are combined into system	-
2. Automatic Air Connection and Valve Control: Automatic Air Connection with Coupling Automatic Mechanical Air Valve Operation Push Button Uncoupling from Side of Car Automatic Train Brake Control at Uncoupling	230	282	245	245	460	460
3. Full Electro-Pneumatic Control: Automatic Disengagement of Positioning at Coupling Remote Uncoupling Capability Time Delay Brake Setting at Uncoupling Automatic Electrical Connection at Coupling Train Condition Sensing Capability Multiplexing Control from Locomotive	910	1,122	750	935	1,045	1,445

Notes: (1) All costs are estimated based on constant 1975 dollars.
(2) "Average" car assumes a mix of 95% short cars and 5% long cars.
(3) Cumulative system costs assume that all modifications would be done simultaneously and include reductions for some redundant subsystems.

7. DEVELOPMENT RECOMMENDATIONS

7.1 COUPLING CONCEPTS PROGRAM REVIEW

It is desirable to place the various elements of the program for assessment of automatic coupling concepts into proper perspective. To accomplish this end, a restatement should be made of the fundamental ideas used to determine Candidate Coupling Systems.

7.1.1 <u>System Automation Versus Capabilities</u>

Performance capabilities of automatic coupler systems are inherently associated with the degree of automation and complexity of the system. In the initial stages of increasing automation, improved system capabilities can be implemented without increasing the inter-car connections beyond the coupler and single airline system. On the other hand, some more complex degrees of automation cannot be accomplished without the addition of a complex inter-car control system and/or individual car logic systems. The changes required for this latter system are both technically complex and very costly as compared to those elements of automation which can be achieved within the present inter-car system limitations.

Increased coupling capabilities which can be accomplished within the framework of the present inter-car connection system include:

1) Consistent automatic coupling of cars (to achieve effective coupling, it is required to have greater coupler gathering range, some form of automatic centering or positioning, and a means of automatically interlocking the coupled units).

2) Provision for automatically leaving the coupler in the "knuckle open" position at the time of uncoupling (this requires provision of a spring loaded system which will automatically open and maintain open the knuckle after coupling pressure is released).

3) Automatic connection of airline provided by an air connection system which is attached to or an integral part of the coupler head so that air connection is made simultaneously with the mechanical coupling).

4) Automatic operation of the angle cock valve (achievable as part of a mechanical or pneumatic control system associated with the coupling of air connector and operation of the car uncoupling lever).

5) Automatic application of car brakes if an accidental uncoupling occurs (inherent with the present airline brake control system and can be associated with the controls of the automatic air valve system noted in 4 above).

The following increased coupling system capabilities are associated only with the availability of a more highly automated inter-car connection system:

1) Remote uncoupling control of any car in the train (this requires a multi-channel inter-car electrical control system and/or individual car electrical logic and pneumatic actuation systems).

2) Control of brakes on a portion of the train (this requires the complex inter-car connection system and individual car logic systems as well as the necessary pneumatic controls required to remotely actuate brake valves).

3) Train sensing systems (this requires an extensive inter-car electrical connection system as well as the required car sensory and transmission systems).

7.1.2 Summary of Capabilities of Candidate Coupling Systems

The detailed listing of capabilities, advantages and disadvantages of each candidate coupling system was included in Section 5. A brief summary of the capabilities of each system follows:

1) System 1 - Compatible "Free Knuckle" System

(a) Has the primary advantage of being totally compatible with all freight cars currently in the U.S. rail-freight system. The primary capabilities of the basic Systems 1-1A and 1-1B include: increased gathering range, knuckle open capability and coupler entrapment and interlock features, thus overcoming the major mechanical deficiencies in the present Type "E" system.

(b) System change 1-2 adds the automatic air connection and automatic brake valve control as a mechanical function of the coupling and uncoupling processes. These features overcome the most critical safety needs relating to the necessity of a trainman going between cars to complete the air connection system or to prepare cars for proper coupling.

(c) System Change 1-3 adds the capability of remote control by the additional electropneumatic and electronic control systems. This latter feature embodies the long-range potential for complete sensing and control of train operations from the locomotive or from some external control point. This system is limited to approximately 6-8 electrical contacts in the automatic electrical connector.

2) System 2 - Noncompatible, Semirigid, Spread-Claw, Hinged Hook System

(a) The primary advantages in this system are the very wide gathering range which it offers. A rugged and proven system 2-1 includes an integral air connection coupling which is protected within the face of the gathering claws of the coupler.

This protection feature is the best of the three systems in that it offers significant mechanical and environmental protection to the automatic air connection face. Since the automatic air connector unit represents a most significant and critical feature in the train operating sequence, candidate system 2 offers a particular and unique advantage in this respect.

(b) System Change number 2-2 is limited, similar to System Change 1-3, to approximately 6-8 electrical contacts which can be readily added to the system for the final step involving electrical sensing and control circuits.

3) System 3 - Noncompatible, Rigid, Flat-Face, Hinged Hook/Funnel System

(a) The basic coupler System 3-1 contains the unique advantage of being a totally rigid system which gives an exceptionally stable platform for attaching air or electrical connectors. This advantage is accompanied by the disadvantage of a heavy coupler unit which requires a significant amount of machining to achieve the slack-free characteristic and which likewise requires a critical positioning control in order to prevent oblique coupling forces from damaging the coupler head faces. The primary advantages of the basic system are its increased gathering range, "knuckle open" capability, rigid interlocking of mated couplers and an integral air connection system.

(b) System Change 3-2 adds the capability for a large number (50-100) of electrical contacts as part of an electro-pneumatic control system.

7.2 LIMITS FOR ADVANCED COUPLER SYSTEM APPLICATION

There are many areas in the rail car fleet where none (or very little) of the operating problems mentioned in Section 2 are encountered. In particular, in some unit train situations the coupled cars essentially remain as an intact unit for extended periods of time. The same is true for other specific dedicated service trains hauling such basic commodities as grain. For this type of application, there is such a small potential for any economic gain from improved operations or for improved safety, that a change to any other advanced coupler system would not have a high priority.

Unit trains set aside for dedicated service operation represent a sizable portion of business of several freight rail lines. Moreover, this type of dedicated service is anticipated to increase for these particular applications in the future.

The application potential in the immediate future for any of the advanced coupler systems noted in Section 5 above is therefore considered to be applicable only to the so called "average car."

7.3 DEVELOPMENT PLAN

The most fundamental decision must be that of choosing between a fully compatible system (System 1) and a noncompatible system (Systems 2 or 3). This decision must be based on an analysis of rail freight operations as impacted by the various elements of each system. The listed system advantages and capabilities should be fit into the operating model to determine the potential economic savings and/or safety improvements expected to accrue from each concept. The total of these potential savings and the imputed value of safety improvements could then be compared to the estimated system costs.

7.3.1 Electro-Pneumatic Control System

The basic operational model analysis will determine if the potential advantages of the full electropneumatic system outweigh the cost and complexity disadvantages. The next decision relates to the amount of sensing which might be required in the ultimate system.

If only a few sensing signals are desired, the smaller number of circuits in Systems 1-3 or 2-2 would be adequate. If a large number of circuits is desired, the capabilities of System 3-2 are superior. As an alternate to a large number of inter-car electrical circuits, the microwave/alternator/battery system, Concept 450b, could be considered as applicable for any of the systems.

If a microwave control system were used, it would add some system components and delete some. Specifically, the addition of an alternator-battery unit to each car would delete the need for an inter-car electrical connection system. The net result is an estimated increase in overall cost of $450 per "average" car. The net cost increase is not great when compared to the overall cost for the total electropneumatic control system 1-3, 2-2, or 3-2.

It is not believed feasible, however, to interject direct microwave receiving into individual car units because this would require an independent power system to be available in each car with the attendant unrealistic requirements for maintenance of battery power in uncontrolled freight car storage and standby conditions. With the availability of the locomotive engineer and the electronic multiplexed sensing and control system in the locomotive, it is believed more feasible to utilize the engineer and his control system as the contact point betwen the train and any desired external program input.

Therefore, the use of either System 1 or 2 would effectively preclude the possibility of a large number of sensing circuits. It is realized, however, that future multiplexing advancements may permit (and a change in regulations may allow) an unlimited number of sensing circuits transmitted over only two or three electrical connections. This possibility makes the smaller number of circuits (and cost) of system 1 or 2 appear the most logical of the candidate electrical system possibilities.

If the lesser number of electrical contacts is determined to be acceptable, either system 1 or 2 is preferred from a cost standpoint. The choice between these two must be made almost solely on the basis of the relative importance of the two factors:

1) System 1 - advantage of total compatibility with the present system couplers with no coupler head interchange adapter required during any changeover process.

2) System 2 - advantage of greater strength and ruggedness, built-in mechanical protection for air and electrical connectors and larger natural gathering range.

7.3.2 <u>Specific System Considerations</u>

In the engineering analysis effort conducted during this study, several areas were noted which should be listed for specific consideration. These include:

7.3.2.1 Compatible System 1

Sub-system 1-1A proposes the use of a modified Type "E" coupler with a top and bottom shelf as opposed to sub-system 1-1B, which proposes the use of a modified Type "F" coupler with a top shelf. This combination represents the best possible situation for obtaining the desired operational improvements with the least costly overall system.

The single deterrent to the proposed systems may be the ability of a single air connector system to operate effectively with both coupler systems. The cost advantages to the proposed systems are so great that every effort should be extended to achieve a successful development of the one "universal" air connector system.

7.3.2.2 Add-On Air Connector

One of the more critical elements in the Compatible System 1 is the add-on air connector (Concept 22 or 502c). This system has not been proven to be fully capable of gathering and seating and maintaining a reliable seal under all possible conditions with two Type "E" couplers. Even with the addition of the top and bottom shelves (Concept 54), there is still a possibility for vertical slippage of approximately 6 inches between two mated Type "E" couplers. Preliminary data indicate that current air connector designs may have a limit of approximately 5.5 inches of vertical travel for reliable maintenance of the air seal. It should be recognized that these capabilities must be reconciled early in the system development program.

The addition of an automatic air connector system is so important to improvements in switching operations and safety that it might be well to limit the vertical movement between mated Type "E" couplers. This limit could be achieved by location of the top and bottom shelves with only a nominal decrease in vertical curve negotiability of standard cars. This potential should be subject to a detailed technical analysis early in the program.

The importance of the air connector system is such that it should be covered by a separate development specification. Given in Appendix G is a Preliminary Development Specification For Automatic Train Air Line Connector. This preliminary specification addresses itself to both general requirements and specific airline and connection provisions. It is given as a preliminary document covering details reviewed in this study.

7.3.2.3 Centering and Positioning

The addition of centering and/or positioning devices adds a significant cost to each coupler system as noted in the Section 6 costs for subsystems 1-1B, 2-1, and 3-1. These devices, however, offer the potential for a significant decrease in coupler bypasses with an associated increase in operating safety and decrease in maintenance costs.

It has been estimated that positioning devices on long cars would decrease bypasses by 80 to 90 percent. By increasing the coupler lateral gathering range (Concepts 501, 502a, 309, or 9), the decrease should be even greater. Railroad users have noted an "average" of $800 cost to repair a car end every 4 to 5 years solely as the result of bypass damage. Thus, the addition of positioning devices (and coupler gathering range increases) has the potential for saving $140 to $150 per year in addition to increasing operational safety.

7.3.2.4 Environmental Covers

The use of an environmental protective cover (over the electrical connectors) has been set aside for a separate cost estimate in Section 6 for subsystems 1-3, 2-2, and 3-2. The use of such a cover has strong supporters and critics among the railroad technical community. The majority opinion seems to be opposed to the covers as offering an unnecessary environmental protection while adding an expensive and highly unreliable component. Unless a new technical breakthrough is made to achieve a reliable cover system, the Study Team recommends that this element be deleted from the proposed Candidate Coupling Systems.

7.3.2.5 Train-Coupler Dynamics

During the engineering analysis of significant coupler concepts, in several instances it was noted that a potential problem exists with the possibility of a harmonic situation being set up within a portion of the concept apparatus (e.g., within a chain linkage system of a positioning device). This same harmonic situation could be encountered in other coupling concepts as a function of the chain reaction between coupled cars. It is generally accepted that railroads which run mainly trains of homogeneous cars with the same or similar commodities on the same basic road system at the same basic speed, will have a greater potential for problems in resonance or harmonics between cars than will be the case with trains carrying mixed cargo. Since no data are available to determine these parameters, for purposes of this engineering analysis, no consideration has been given to the potential problem of inter-car resonance or harmonics. Tests to develop these data should be included in the final acceptance program for any new coupling system.

7.3.2.6 General Considerations

The development program directed toward improvement in the coupler system should include a secondary study relating to the impact on rail car trucks and other rail car components. It is entirely feasible to assume that significant improvements in gathering range or reduced contour angling of a coupler head may have a deleterious impact on the ability of the draft gear or other supporting mechanism to contain the additional coupling forces which may be imposed upon them. As has been previously noted, the Type "F" interlocking coupler head (Concept 428b) was found to have significant cracking problems at the butt end of the shank, apparently brought about by the increased shank loading associated with tighter coupler interlock and reduced contour angling. This latter problem was not totally expected with the introduction of the Type "F" coupler head in long car service. Other, more dramatic improvements in coupling capabilities may well result in secondary harm to other adjacent car components. Therefore, a secondary impact study should be initiated coincident with the final development effort on a new coupler system.

7.4 TIME SCHEDULE

Considering the rudimentary state of the proposed candidate coupling systems, it is not feasible to project realistic time or cost schedules for either the development or field implementation stages. Given below, however, are some concepts and background concerning the potential time schedules and implementation plan.

7.4.1 Development and Evaluation

The complete development cycle, up to the point of being ready to start changeover to new coupler systems, may well be 10 to 12 years duration. This cycle might generally be composed of the following elements (and ranges of anticipated completion times):

1) Finalization of design concepts: 1 to 1-1/2 years.

2) Establishment of basic design specifications in keeping with AAR and governmental standards: 1/2 to 1-1/2 years.

3) Completion of hardware development as required to meet final specifications: 1 to 2 years.

4) Production of acceptable pilot test units by hardware suppliers: 1/2 year.

5) AAR qualification test program for competing supplier units: 2 to 4 years. (Note - Earlier engineering prototype tests conducted in the mid 1930's by the AAR required 4 years for testing and tabulation of the data.)

6) Field testing in various railroad environments to "debug" final hardware designs and for suppliers to develop reliability confidence that is required to accept ultimate product liability requirements: 3 to 5 years. (Included within this time frame is the time required for the government and/or railroads to develop total quantity needs and delivery requirements as necessary to establish ultimate production contract details.)

7) Establishment of production facilities, tooling and materials as necessary to begin the required deliveries: 1/2 to 2 years.

7.4.2 Field Implementation

It is recognized that the changeover for any new coupler system will involve a lengthy time cycle. The last major change by U.S. Railroads to the Type "D" coupler system was completed in 1916 after approximately 23 years in the change-over process. In Japan, a total of 8 years was spent in planning and logistics preparation in order to make a changeover of 46,000 railroad cars during one day in 1925. The U.S.S.R. spent over 10 years in planning and material preparation plus 22 years to complete the changeover to the SA-3 coupler system in 1957. Even discounting 10 years lost for World War II, over 10 years time was used in a changeover involving significantly less than 1 million cars.

It is thus anticipated that a lengthy changeover cycle will be required for full introduction of a new coupler system. The economics of excess inventory and multiplicity of handling equipment alone would tend to rule out a precipitous changeover period.

A complete logistics study should be made to determine the most economical changeover rate which would achieve the optimum balance of minimum inventory and equipment and minimum lost operational time from use of mixed systems.

7.4.2.1 Conversion Sequence

The application of any new coupling system to the entire general freight system would involve a process of sequentially converting different segments of the cars on each rail line. This general sequence might logically be accomplished as follows:

1) Each railroad's own cars which are most often pre-blocked and used as grouped units within trains. Conversion of these cars would have the greatest impact for savings to each railroad.

2) Cars dedicated for unit train service. Unit trains are subject to the most frequent service and thus are subject to the greatest number of coupling sequences (as a group). Such unit train cars would represent the next largest group for potential savings after change to the new coupler system.

3) Cars subject to major repair involving couplers. Such cars would be readily subject to completion of the conversion program with minimum disruption of total service.

It is recognized, of course, that all new purchased cars should be equipped with the new coupler system. Such new car purchases would be coincident with the three change sequences noted above.

7.4.2.2. Automatic Air Connection System

A two-stage introduction of the add-on air connection system would appear to offer the most economical phase-in plan.

In the first stage, the mechanical air connector (Concept 22 or 502c) would be added together with a train air-line valve which could be operated manually from either side of the car. The standard angle cock and air hose/glad hand would be moved to the other side of the coupler to allow for a regular coupling sequence with nonequipped cars.

In the second stage of the changeover, the required air control system would be added and the remainder of the system for automatic air valve operation (Concept 22) would be installed. The installation of the remote uncoupling button (Concept 674) and the hydraulic uncoupling operating mechanism (Concept 943) could be deferred for a third stage modification should the development of these items lag that of the basic air connector system.

This two-stage introduction approach would provide for the minimum amount of expenditure in the initial stages of application of an automatic coupling system and would provide some considerable benefit in the elimination of the need to couple hoses between equipped cars. The second stage of applying the valves could be delayed until all cars considered for automatic coupling are equipped with the train line connector.

7.5 RELIABILITY OF CANDIDATE COUPLING SYSTEMS

Virtually all of the elements of the coupling systems noted in Section 5 above are composed of concepts which are, at best, in the advanced development stage. As such, the concepts are generally devoid of any associated user data required to predict the ultimate reliability of the concept in actual rail freight service. Some concepts, such as the coupler knuckle contour change (Concepts 501 or 502a), represent such a basic design improvement that it can be predicted with assurance that the overall system reliability will not be compromised by adding this concept in any manner from that available with the present "E" coupler system. On the other hand, such concepts as the multiplexing electronic control system (Concepts 452, 450a, or 387) represent engineering concepts which have yet to be proven under the rigors of rail freight service. For these, no usage data are available to make a reliability prediction.

On balance, therefore, the development, engineering test, field test and manufacturer "field confidence test" must be completed before sufficient data will be available to predict the overall reliability of any of the coupler systems.

Once this basic coupling system reliability has been established, it is suggested that an analysis will be required to equate the cost of the coupling system versus the reliability and the labor savings which that level of reliability represents. It is conceivable that some elements of the final coupling system will be required to have a redundant (or parallel operating) system in order to achieve the best possible trade-off of basic system cost versus total system reliability. Such could well be the case for such items as valves relating to proper functioning of air brakes in that this area must be almost totally reliable as a system in order to achieve the required level of safety.

7.6 DOT/AAR MANAGEMENT OVERVIEW

For the successful conversion to a new coupler system, close cooperation and open information channels will be needed among DOT, AAR, and railroad industry suppliers and users. Some specific areas of management responsibility would include the following.

An early pronouncement should be made to the railroad supplier community as to the potential for production business which could result from the proposed coupler change program. A clear message was received from this group that they will require a positive statement on the future market potential as a requisite to committing the funds needed to complete new designs.

A significant reason why new developments have not been forthcoming has been the reluctance of industry suppliers to market a new product without an overwhelming evidence of test results proving the ultimate safety and reliability of these products. The railroad industry market place has been such that price has been the primary consideration for purchase of any new equipment such as a coupling system. This competitive situation has apparently not allowed the level or profitability to protect the industry suppliers against potential liability losses should one of the new concepts prove to be less than fully reliable. These factors contributed to the paucity of new coupling concepts being offered for volume sales through the railroad industries and should be considered in overall planning efforts directed toward introduction of a new coupling system.

To aid in supplier development efforts, it is necessary that specifications be changed or clarified as needed to define the allowable variations for new coupler systems. This applies particularly to the area of allowable changes to air lines, limitations on automatic air connectors, allowable changes to angle cock locations, etc. A concerted effort will be required to oversee the timely processing of needed changes to rules, regulations and specifications.

Engineering prototype tests should be conducted with full cognizance from the Office of Safety of the Federal Railroad Administration, designated committees of the DOT, designated representatives of the cognizant railway unions, and designated representatives of other interest groups (i.e., OSHA).

A detailed engineering analysis should be made by the cognizant AAR technical groups to establish an agreed upon standard for acceleration of the test schedules required to prove the adequacy of any new coupler design concept. Reference should be made on reliability testing techniques used by NASA in aerospace development and as currently used by the EPA for such items as automobile emission test programs. The accelerated test programs should be based on the use of statistically chosen sample sizes and test parameters to achieve the greatest possible technical information in the least time while meeting the desired reliability and safety standards.

APPENDIX A

GLOSSARY OF TERMS

1) Automatic Coupler - (Synonymous with Coupler in AAR Terminology.)

2) Automatic Coupler - (European Terminology) - Full mechanical coupling upon contact; but require manual uncoupling.

3) Automatic Lock Set - The coupler knuckle is locked open automatically at completion of the uncoupling cycle.

4) Bad Order Car - A car which must be removed from a departure train due to a need for repair.

5) Bleed - A term commonly used for venting of car air pressure.

6) Bowl - The holding area for cars in a hump switching yard after switching and before train makeup.

7) Buff - Couplers being pushed together (train slack bunched).

8) Center Sill - The main longitudinal member of the underframe of a car.

9) Cock - A manually operated valve device used in air lines to permit or prevent the flow of air.

10) Coupler - An appliance for coupling cars or locomotives together.

11) Coupler, Type D - Adopted in 1916 by the Master Car Builders Association (predecessor to AAR) as the first standard coupler

in which the parts produced by all manufacturers were completely interchangeable.

12) <u>Coupler, Type CS</u> - (Controlled Slack Coupler), adopted by AAR in 1956 for passenger service. Incorporates the safety interlocking features and reduced free slack of the Type H while using some standard parts of Type E.

13) <u>Coupler, Type E</u> - The AAR Standard Type "E" Coupler design which was adopted as the standard design on American Railroads on March 1, 1934.

14) <u>Coupler, Type F</u> - An alternate coupler design adopted on March 1, 1954 as an alternate for use on tank cars, hazardous cargo and very long cars. Type F contains the interlocking features of Type H, is stronger than Type E and results in 52% less slack between coupler heads.

15) <u>Coupler, Type H</u> - Also known as the "AAR Tightlock Coupler," an alternate coupler designed for use on high speed passenger cars and adopted for use on March 1, 1938. This coupler improved the Type E design by having less free slack and an interlocking feature which allows no vertical movement between adjoining couplers to reduce potential for car telescoping and jackknifing. Also, the Type H has improved safety characteristics in that it will support a free mated coupler which has

		detached from an adjacent car.
16)	Contour Angling Capability	- Tendency of coupler to angle outward from the track center line as the car is traveling around a curve (usually expressed as the angle between coupler centerlines of adjacent cars at the time of coupling).
17)	Coupler Butt	- The end of the coupler shank opposite the head.
18)	Coupler Centering Device	- An arrangement for maintaining the coupler normally in the center line of the car, but allowing it to move to either side when a car is rounding a curve, while coupled to another car.
19)	Coupler Head	- That portion of the coupler which houses the coupling mechanism.
20)	Coupler Knuckle Lock	- The block which drops into position when the knuckle closes and holds it in place, preventing uncoupling.
21)	Coupler Lock Set	- A device by which the knuckle lock when lifted is held in a raised position until the knuckle is opened, when it allows the lock to drop back into position for automatically coupling when the cars are brought together.
22)	Coupler Positioning Device	- Similar to Coupler Centering Device, except that it is actuated from the relative movement between the car and trucks and maintains the coupler toward the center line of the tracks.

23) <u>Coupler Shank</u> - The back end or body of a car coupler. Also called coupler butt.

24) <u>Coupler Yoke</u> - The yoke or strap that surrounds the draft gear and is keyed to the end of the coupler shank. Also called Draft Yoke.

25) <u>Crossover</u> - Curved section of track coming into and leaving a tangent (or straight) section abruptly on opposite sides.

26) <u>Departure Yard</u> - The yard area where air hose connections are made and outbound inspections performed prior to the train departing.

27) <u>DOT</u> - U.S. Department of Transportation.

28) <u>Draft</u> - Couplers being held in tension or being pulled apart (train slack out).

29) <u>Draft Gear</u> - The name of that unit which forms the connection between the coupler rigging and the center sill. The purpose of this unit is to receive the shocks incidental to train movements and coupling of cars, and cushion the force of impact. The types of draft gear now in use are known as friction spring, rubber, and hydraulic.

30) <u>Draft Yoke</u> - Synonymous with Coupler Yoke.

31) <u>Draw Bar</u> - A term formerly used synonymously with Coupler.

32) <u>Draw Bar Pull</u> - The force exerted on the coupler between the locomotive and the car which is equal to the locomotive tractive effort less the rolling

resistance of the locomotive.

33) <u>Draw Head</u> - The head of an AAR automatic coupler, exclusive of the knuckle, knuckle pin and lock.

34) <u>Dummy Coupling</u> - A device designed to couple to an unused air hose to protect against damage to the hose and coupling, as well as preventing entrance of foreign matter into the hose.

35) <u>Floating Sill</u> - Synonymous with Sliding Sill.

36) <u>Followers</u> - Plates or blocks of metal placed inside of the coupler yoke and bearing against the ends of the draft gear. Their function is to transmit the stresses of compression to the draft gear and the center sills.

37) <u>Free Slack</u> - The amount of unrestricted movement (or slack) resulting from accumulation of clearances and wear between coupled adjacent coupler knuckles, exclusive of draft gear slack.

38) <u>Fully Automatic Coupler</u> - (European Technology) - Full mechanical coupling upon contact with uncoupling provisions not requiring manual assist.

39) <u>Gathering Range</u> - The amount of horizontal or vertical distance from the coupler center line within which the coupler will operate properly when coupling.

40) <u>Glad Hand</u> - The metal-end pieces of the air hose couplings which are joined together so that the air by which the brakes are operated can pass from one

vehicle in a train to another. (Synonymous with Hose Coupling.)

41)	Hose Coupling	-	Synonymous with Glad Hand.
42)	Hump Yard	-	A switching (or classification) yard in which a raised portion of track (or hump) is used for uncoupling cars, permitting individual cars to coast downhill into the proper classification tracks.
43)	Knuckle (Couplers)	-	The rotating coupling hook by means of which coupling is effected.
44)	Knuckle Pin (Couplers)	-	The pin holding the knuckle in the jaws of the coupler. Sometimes called pivot pin.
45)	Knuckle Thrower	-	A device which throws the knuckle of a car coupler open when the uncoupling rigging (or lever) is operated.
46)	Lateral Motion	-	The motion which takes place, crosswise of the track, of all car parts, except the wheels and axles.
47)	Link and Pin	-	An old type of connection between cars which employed a chain link and a pin arrangement.
48)	Lock Set	-	Unlocking the coupler knuckle as required for uncoupling (usually by unlatching the lock lifter mechanism which holds the knuckle lock in the raised position).
49)	Manual Screw Coupling	-	The coupling system presently employed in Europe. An elongated link from one car is manually hooked over a draw hook on the adjacent car. The coupling is then tightened up

by hand by turning a coupling screw at the base of the coupling link.

50) Master Car Builders Association - The predecessor organization to the Association of American Railroads.

51) Mixed Coupling - An adapter device which enables two rail cars fitted with different types or styles of couplers to be coupled together.

52) Pivot Pin - Synonymous with Knuckle Pin.

53) "Push-pulled" Car Movement - The process of moving a car by other means than a coupled connection (i.e., hand pushing).

54) Rip Track - An area of track set apart for repair efforts on cars.

55) Self-Aligning Coupler - A coupler which has a tapered shank rather than a straight shank to prevent the jackknifing of cars.

56) Shank (Coupler) Head - That part of a coupler between the butt and the head.

57) Side Buffers - As applied to European rail cars - side buffers are used in conjunction with spring buffers positioned at either side of the coupling. The purpose of the side buffers is to absorb shock when vehicles come together, to transmit the compression effect in sets of vehicles being pushed, to deaden the longitudinal reaction in moving trains and to dampen the transversal movement of vehicles in fast running trains whose couplings must be tightly screwed.

58) <u>Sliding Sill</u> - The structural through member which connects the coupler to the car under frame. This unit slides or moves against a cushioning device to absorb the coupling shocks.

59) <u>Spring Slack</u> - The amount of unrestricted movement (or slack) resulting from the cushioning action of the draft gears.

60) <u>Tangent Track</u> - Track in which both the car and truck center lines of adjacent cars are on the same straight line.

61) <u>Train Run-In</u> - The distance required to move all cars in a train together until all couplers and draft gears are in buff.

62) <u>Train Run-Out</u> - The distance required to move all cars in a train together until all couplers and draft gears are in draft.

63) <u>UIC</u> - International Union of Railways.

64) <u>Uncoupling Lever</u> - A rod with a bent handle forming a lever, by which the lock of the automatic coupler is manually opened and the cars uncoupled without going between them.

65) <u>Uncoupling Mechanism</u> - (Synonymous with Uncoupling Lever.)

66) <u>Uncoupling Rigging</u> - (Synonymous with Uncoupling Lever.)

67) <u>Uncoupling Rod</u> - (Synonymous with Uncoupling Lever.)

68) <u>Vertical-Knuckle Couplers</u> - A coupler in which the knuckle rotates about a vertical axis (such as the AAR types "E" or "F").

69) <u>Vertical Interlock</u> - A coupling design (such as the AAR coupler type H) in which there is a positive holding or interlocking of couplers in the up-and-down position.

APPENDIX B

ABSTRACTS AND PATENTS

B.2 ABSTRACTS OF LITERATURE SOURCES

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference
1*	033032 (RRIS)	Technical Proceedings of the Engineering Forum. Symington Wayne Corporation, Depew, New York, September 22, 1966, 53 p.

The proceedings include eight papers from the 1966 Railroad Engineering Conference of Symington Wayne Corporation. The topics discussed are marketing, cushioning requirement trends, and engineering aspects of new car design; philosophy of car design; high speed truck design; car roll and wheel lift tests; and coupling.

One paper discussing further coupling requirements for freight cars calls for an examination into the methods of reducing slack, analysis of stress between cars; and the basic design of freight cars. A paper dedicated to engineering and operational considerations in fully automatic coupler development suggests an industry need for reconsidering total car design and construction. The paper outlines automatic coupler requirements and presents a detailed and pictorial explanation of the design issues in cars negotiating a curve.

Conference commentary and questions related to the papers are published in the proceedings.

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* Denotes abstract for significant coupling concept.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference
6*	037633 (RRIS)	"Prototype Automatic Coupler for British Railways." Railway Gazette, May 31, 1957, Vol. 106, pp. 625, 628.

The prototype A.S.F./v automatic coupler was designed for use on high-speed freight trains. The unit is one of the first to be equipped with either an automatic vacuum or air connector. The present prototype of the coupler is designed to take a drawbar pull of 40,000 lbs., but it will be tested with a load of 140 tons giving a safety factor of approximately eight to one. This second prototype has a greater range of buffer height and incorporates the hydraulic draft gear as an alternative to the rubber gear fitted to the first unit.

8*	037721 (RRIS)	Cope, G. W. "Coupler Centering Devices." Technical Proceedings, Railroad Engineering Conference, Symington Wayne Corporation, Depew, New York, September 23, 1965, pp. 40-43.

The geometry of car length and length of the free swinging coupler (necessary to allow for negotiating curves) is such that the possibility of a miscoupling is almost as likely as a successful coupling.

A proposed solution is a coupler centering device which would automatically position the coupler over, or sufficiently close to, the center line of track thus assuring better chance of successful coupling. Cushion underframe cars present the most difficult application of the proposed solution because the floating sill complicates the connection between the truck and the coupler.

The coupler centering design is predicated on the fact that

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

the only time when there is a need to center the coupler is when the car is uncoupled. When coupled, it is being centered by the other car. The stresses in the mechanism are relatively low requiring approximately 600 pounds in the top rods to move the coupler from side to side. It is expected that the maximum stress on the flange of the wheel would be 1,000 to 1,200 pounds for only a short duration on tangent points and on reverse curves.

9*	037722 (RRIS)	Martin, A. "The Fully Automatic Coupler." Technical Proceedings, Railroad Engineering Conference, Symington Wayne Corporation, Depew, New York, September 23, 1965, pp. 43-48.

This paper discusses the concept of a fully automatic coupler for freight or passenger cars that would have the strength and safety of the "F" and "H" type couplers. To realize the full economic value of many innovations in railroad design and operating techniques, it is imperative that trains can be made up and broken down automatically, accordingly a fully automatic coupler is required.

Consideration and study of several alternative plans have resulted in the concept of a hook type coupler similar to that used on subways. This coupler basically is of the same general construction as a heavy duty subway coupler used in Rapid Transit operation. One of the basic improvements is the application of a positive lock. The coupler comprises the main body, a hook spring, a positive lock, an operating cam with an integral lock operating lever and linkage, a cam operating lever and an air cylinder.

This coupler is always ready for coupling, it is simply

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

brought into contact with the mating coupler and the hooks engage and lock immediately after the faces are in contact. In the coupled position, the hooks are fully engaged and the positive lock is seated behind the hook nose of the mating coupler to eliminate any possibility of an unwanted uncoupling for any reason. In order to uncouple, the air cylinder is activated and moves the cam operating lever in a counter-clockwise direction. The first increment of movement of the cam and the integral arm is used to shift the positive lock clear of the hook nose, and then the cam spreads the hooks to effect an uncoupling. Both hooks must be moved over the full limit of travel against the hook springs in order to uncouple.

Since the positive lock secures the hook of the mating coupler it is necessary to provide means to operate the positive lock of the mating coupler when uncoupling manually or under certain conditions of automatic operating. To do this, an interacting linkage has been provided which, when coupled, forms a parallelogram through the coupler to transmit the operating lever movements to the operated coupler to the mated coupler operating lever and thus, actuate both positive locks simultaneously.

13*	037749 (RRIS)	Reed, R. T. "High Speed Transit Engineering." Technical Proceedings, Railroad Engineering Conference, Symington Wayne Corporation, Depew, New York, September 14, 1967, pp. 50-58.

When the High Speed Ground Transportation R & D Act was enacted, a committee was established by cognizant Pennsylvania Railroads Departments to establish criteria and develop specifications for a self-propelled electric multiple unit railroad

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

passenger car. The Pennsylvania awarded a contract for the purchase of 50 cars to the company meeting all their requirements. Details of the design are described and illustrated. Emphasis is on suspension and coupling.

15*	037851 (RRIS)	Bulleid, O. V. S., "Automatic Couplers and Compressed-Air Brakes." Railway Gazette, April 26, 1963, Vol. 118, pp. 469-472.

The article deals with automatic couplers and compressed-air brakes. Inherent advantages are cited for automatic couplers along with refinements for the future automatic coupler.

Coupler advantages identified are:

i) increased safety for the shunters

ii) quicker breaking-up and reforming of trains

iii) reduction of staff

iv) increased strength of couplers permitting heavier train loads and increased line capacity.

The Unicupler (developed for the Russian S.A. 3 type) and the Fischer coupler designs are discussed as examples of couplers meeting U.I.C., the International Union of Railways, specifications. Coupling problems are considered and the importance of practical testing and experimentation stressed. Air brakes, electrically-controlled brakes, and coupling connections are commented on relative to coupler design considerations.

Finally, capital expenditure is discussed along with economics affected.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference
22*	039510 (RRIS)	Punwani, S. K. "Automatic-Pneumatic Coupling for Increased Utilization." Technical Proceedings, Railroad Engineering Conference, Dresser Transportation Equipment Division, Depew New York, September 12, 1969, pp. 56-59.

The Automatic Pneumatic Coupling System design by Dresser Transportation Equipment is described and illustrated. The system consists of a train line connector for making the physical connection between car ends; valves to control the air; and a means to initiate the coupling and intentional uncoupling of air and to sense unintentional uncoupling. The system is compatible with knuckle couplers already in service. Field tests were scheduled for 1970.

25*	039515 (RRIS)	Cope, G. W. "New Coupler Concept for Long Cars." Technical Proceedings, Railroad Engineering Conference, Symington Wayne Corporation, Depew, New York, September 24, 1964, pp. 10-18.

The "LC" coupler was developed specifically as a solution to the long car tracking and curve negotiation problem.

The "LC" coupler comprises a coupler with a Type "F" Head, a shank extension having an "F" Butt, with the aligning shoulders removed, a coil spring, spring seat, retainer block, pin and two retainer plates. The Type F Head was selected to limit the amount of contour angling to avoid possible jackknifing. A 72" length was selected on the basis of calculations on stress, track curve negotiability and derailing components. Photographs show the coupling system.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference
26*	039516 (RRIS)	Tarbox, I. F. "A Single Standard Design Coupler for Conventional Freight Cars." Technical Proceedings, Railroad Engineering Conference, Symington Wayne Corporation, Depew, New York, September 24, 1964, pp. 18-24.

Problems with "E" Rigid Shank and "E" Swivel Couplers are listed and an improved coupler is described. It is hoped that the coupler designed by Symington Wayne will be adopted as a single standard E coupler for conventional freight cars. The coupler has a controlled swivel coupler assembly which permits maximum angularity of 15 degrees. At all angularity beyond 4 degrees, a seat compresses the draft gear, which returns the coupler to the 4 degree position, when the lateral force is removed.

The article contains several detailed sketches and illustrations.

27*	039517 (RRIS)	Cope, G. W. "Development in Fully Automatic Couplers and Potential on Automated Freight Trains." Technical Proceedings, Railroad Engineering Conference, Symington Wayne Corporation, Depew, New York, September 24, 1964, pp. 24-30.

A fully automatic coupler is defined as those which can be operated by the push of a button from a remote position to control mechanical, electrical, and pneumatic coupling and uncoupling.

The automatic coupling system developed by Symington Wayne for subway and rapid transit cars is illustrated and described. This equipment manufacturer is now considering the design of an

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

4) Axial play effect on passenger comfort.

There is a brief summary with two drawings related to the eurocoupler-68 described to be a combination of the Scharfenberg coupler and the Willison-profile.

38*	044067 (RRIS)	"Coupler Is Subject of Two Safety Projects." Railway Locomotives and Cars, February, 1973, Vol. 147, No. 2, pp. 18-19.

The freight car coupler's sphere of operation is one of almost constant violence. Couplers must take the brunt of crushing forces, and when problems occur, the strong coupler can damage other car components.

A key safety recommendation is that car couplers should be modified to prevent uncouplings in derailments. Both the Type F coupler, with a top shelf, and the Type E coupler, with top and bottom shelves, have the ability to reduce the probability of vertical separation. For better than two years, the Type F coupler has been required on new tank cars. It is felt the Type E coupler would not only do a better job of preventing punctures of tank cars, but would be more cost effective. Service testing of 200 car sets of the Type E coupler is now in progress. Plans call for an instrumented boxcar to be operated over 25,000 miles by more than eight railroads to produce a fair sampling of the railroad environment.

41*	050543 (RRIS)	"High-Cube Cars Have Created a Market for Coupler Positioning Devices," Railway Locomotives and Cars, January, 1973, Vol. 147, No. 1, p. 8+

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

automatic coupling system for freight trains.

The paper contains several photographs and drawings in addition to a general discussion of the need for automatic couplers and references to developmental work on these devices.

31*	039915 (RRIS)	Cope, G. W. "Innovation Potential Inputs." Technical Proceedings, Railroad Engineering Conference, Dresser Transportation Equipment Division, Depew, New York, September 13, 1968, pp. 34-38.

The article is a discussion of problems in coupler positioning. The problems of car length and overhang require the use of positioning devices to avoid car end damage. Mechanical, hydraulic and "swing draft sill" devices are described. Seven advantages of the "swing draft sill" devices are listed and discussed.

33* and 303	040143 (RRIS) 844 (R-TRIS)	Bobbert, G., and A. G. Salzgitter, "Adapting the Automatic Coupler to Future Developments on the Railways." Eisenbahntechnische Rundschau. March, 1969, Vol. 18, No. 3, pp. 94-97.

The article discusses four new development trends in European couplers:

1) The effect of container utilization on the introduction of center buffer coupling.

2) Decoupling of rail cars without manual operation using coded signal methods.

3) Adapting couplers to railcar characteristics--with the Russian SA-3 as an example.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

Since coming on the railroad scene less than ten years ago, the high-cube parts car has shown an alarming affinity for passed coupler damage. The coupler centering and positioning devices can, in the majority of instances, prevent the passing of couplers.

Operational aspects and advantages of positioning devices were presented.

45*	052607 (RRIS)	Test on Automatic Couplers. Work of committee B51 from January 1972 to December 1973 and the Current State of the Studies and Tests Relating to the Introduction of the Automatic Coupler. International Union of Railways, Office for Research and Experiments, Utrecht, The Netherlands, ORE Report No. B51/RP, 15/E, April, 1974, 64 p.

The report gives an account of the current state of the work carried out in connection with the introduction of the automatic coupler and the studies and tests made for this purpose from January 1972 to December 1973. Special attention was given to the following questions:

1) Studies and tests relating to the design of the basic type of the automatic coupler and completion of this work;

2) Studies and tests relating to the riding stability of wagons with automatic centre buffer couplers with the object of:

(a) Limiting the longitudinal compressive forces in the train by a suitable choice of elastic systems and variation of the brake characteristics.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

(b) Controlling the longitudinal compressive forces in the train by the use of a stabilizing articulation with vertical and horizontal alignment control, in short, a universal articulation.

3) Studies and tests with passenger coaches equipped with automatic couplers, mixed air couplings, intermediate parts for train ferry services and different types of electric plug contacts, relating to the question of coupler wear in service, to the need for protection covers and to shunting procedures to be used for wagons equipped with automatic couplers;

4) Current state of the work on the compilation and revision of several UIC and Joint UIC/OSJD Specification Leaflets.

46*	057181 (RRIS)	"Some Aspects of Automatic Center-Couplers Applied to Europe," Rail Engineering International, May 1974, Vol. 4, No. 4, pp. 158-160.

The decision to introduce centre-automatic couplers as the sole draw and buffing gear and obviate the manual uncoupling and coupling up of trains has been the subject of a great deal of attention by railways and industry alike. A point raised by some administrations highlights the advantages obtained by controlling the train by the locomotive brakes only when this can be effected through the transmission.

Braking concepts are presented and five requirements for couplers are itemized and discussed. Drawings of a Eurocoupler and the Russian SA3 couplers are included.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference
47*	057405 (RRIS)	Salmon, P. "Simplified Automatic Couplings for the Railroad Rolling Stock of Iron and Steel Plants (Attelage Automatique Simplifie Destine aux Vehicules Ferroviarires des Usimes Siderurgiques)," <u>Revue de Metallurgie</u>, February, 1974, Vol. 71, No. 2, pp. 157-182.

The new coupling and the tests having led to its development and adoption by steel plants and other railway systems are described. The development work was a joint French and German project.

Numerous drawings and photographs illustrate the report.

49*	072700 (RRIS)	Winter, P. "Automatic Coupling of Railroad Cars (L'Introduction de L'Attelage Automatique)," <u>Bulletin Technique de la Suisse Romande</u>. Vol. 100, No. 16, pp. 330-333.

The article summarizes the installation procedure, cost estimates and related problems of installing the unicupler UIC automatic coupler. Winter lists three priorities of new railroad car acquisitions as related to automatic couplers. Several illustrations are included and a few cost statistics are presented in tabular form.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference
52*	080337 (RRIS)	Sims, R.D. Couplers and Truck Securement, Phase 10 Report. Chicago Association of American Railroads, September 1973, 35 p. (Final Report: #RA-10-2-19 R-142).

Phase 10 of the RPI-AAR Tank Car Safety Project was established to study the influence on tank car behavior in accidents of all nontank components of a tank car. Of these components, couplers and trucks were later selected as the only significant items for study. The influence of couplers on tank car accidents was evidenced by the accident data collected for the years 1965 through 1970. During this six-year period, 173 tank cars incurred head punctures and, of these, 148 were known to have been caused by couplers on adjacent cars. The data also showed that truck components, particularly wheels, often punctured tank car shells. Finally, of interest was the influence on the severity of derailments (i.e., number of cars derailed and degree of jackknifing) of various coupler designs and the concept of truck securement. The purpose of this report is to review and discuss the results of the studies and to draw conclusions regarding functional efficiencies of current and modified coupler and truck designs toward improving tank car safety in accidents.

254*	PB 225-934 Sec. 4 (NTIS)	Boeing Vertol Company, Surface Transportation Systems Department, Philadelphia, PA. Detail Specification for State-of-the-Art Car. Prepared for the U.S. Department of Transportation, Urban Mass Transportation Administration, May 1973, Revision A, October, 1973 (PB 225-934).

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

This document is the detail specification for the State-of-the-Art Car (SOAC). This specification represents the SOAC configuration as delivered to the Urban Mass Transportation Administration (UMTA) for test and demonstration.

The SOAC has been developed under UMTA's Urban Rapid Rail Vehicle and Systems program which has the objective of enhancing the attractiveness of rapid rail transportation to the urban traveler by providing him with transit vehicles that are as comfortable, reliable, safe, and economic as possible. The SOAC is one phase of this program.

This specification was prepared by St. Louis Car Division, General Steel Industries, Inc. It has been reorganized into the format of the "Guideline Specification for Urban Rail Cars" by the Boeing Vertol Company, Systems Manager for the Urban Rapid Rail Vehicle and Systems Program.

301*	1199 (R-TRIS)	"Provisions of a Standard Automatic Coupler for Europe," <u>Railway Gazette</u>, August 1, 1969, Vol. 125, No. 15, p. 572+.

The deadline for the conversion of conventional draw and buffing gear of Continental standard guage rolling stock to automatic couplings is Easter, 1976. The advantages to be gained from this change are heavier trains, reduction in shunting man-hours and enhanced train stability. Two basic designs and the problem of compatibility of variations of these are discussed.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference
305*	1211 (R-TRIS)	Zeevenhoven, N. "Designing a European Autocoupler," Railway Gazette, October 20, November 3, November 17, 1967, Vol. 123, No. 20, p. 780+; No. 21, p. 825; No. 22, p. 854+.

In Part I, the author reviews basic coupler types and analyzes the principles underlying the Willison type coupler. Four reasons for European delay in adopting automatic couplers are listed.

Part II deals with the present stage of development and the operational economies to be gained and Part III with the problems of the changeover to autocouplers and derailment considerations.

Numerous illustrations accompany the papers.

306*	82 (R-TRIS)	"Car Truck Movement Steers New Coupler Aligning Device," Railway Age, July 25, 1966, p. 58.

Reference is made to the difficult problems involved in the automatic coupling of extremely long bogie wagons. A photograph shows a device for aligning the couplings in relation to the layout of the track, on straight and curved sections. A set of chains, tightened by means of springs, is used to fasten the coupling device to the bogie underframe, in such a way that the movement of the bogie on curves steers the coupling, to enable automatic coupling to take place with another wagon, without any risk of the two coupling heads overriding.

308*	411 (R-TRIS)	"Europe Decides on Automatic Couplers," International Railway Journal, January, 1966, Vol. 6, No. 1, p. 50+.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

This paper is directed at the issues of adopting a standard automatic coupler in Europe. Many statistics are quoted in the body of the article including an estimated total car conversion cost of greater than two billion U.S. dollars. A photograph shows a top view of the Willison interlocking Type II coupler. The Knorr-Bremse Unicoupler and Willison designs are analyzed.

309*	1199 (R-TRIS)	"European Centre Couplers," <u>Railway Gazette</u>, October 15, 1965, Vol. 121, No. 20, p. 809+.

The paper reviews the history of center couplers on European railways. A brief summary is given for the three main design and manufacturing groups,

1) Unicoupler
2) Boirault-Sambre and Meuse and
3) Associated Willison

Major coupler requirements were identified as:

1) The automatic coupling of air-brake pipes and electric cables supplemental to the mechanical coupling in a drag-and-buffing coupler;

2) The practicability of coupling up with the Soviet SA3 type. The first requirement was expanded to include the possibility of air-pipe coupling when double-pipe brake systems are used. Several drawings illustrate the documentary.

318*	861 (R-TRIS)	"ORE - The Cross-Beam Support, A Principal Component of the Automatic Coupling, Now Standardized and Internationally Licensed," <u>Rail International</u>, February, 1970, p. 139+.

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

The article deals with ORE document B51/RP7 (cross-bearer suspension), which provides an explanation of the construction and operation of cross-bearer suspension, together with details of the experiments and research which have enabled a judgment to be made of its constructive, operating and maintenance characteristics, and in which its dimensions and size, as well as diagrams of the springs, are shown.

391	250862 (COMPENDEX)	Harada, R. and W. Schulte. "Effect of the Center Buffer Coupling on the Operation of Steel Works." Stahl, February 19, 1970, pp. 161-167.

The article describes a rigid type, flat face, horn-funnel, heavy duty tight-lock automatic coupler capable of connecting pneumatic and electrical lines simultaneously. The authors claim the coupler is capable of use in trains made up of large railway vehicles as well as high-speed trains of locomotive traction system. The strength of the coupler is reputed to be approximately twice that of the tight-lock couplers currently used in Japan. Test and performance data are included in the written description.

405*	44009 (TRIS)	"Tank Car Safety Project...Milepost in Railroad Research," Progressive Railroading, Murphy-Richter Publishing Company, Vol. 16, No. 2, March 1973, pp. 57-58.

Tank cars are identified as unique relative to other freight cars due to the nature of the liquid, viscous, or gaseous materials transported. The article summarized results of a $1.25 million research project completed by the Railroad Tank Car Safety

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference

Research and Test Project. The research group recommended that E couplers with the top and bottom shelf be installed on all new tank cars. The nature of the shelf coupler is explained with conversion of existing cars to incorporate the shelf coupler estimated at $97 per car.

447*		UIC leaflet No. 522i, Requirements for European UIC Synopsis coupler, January 3, 1972.

General Information

The automatic coupler should be as simple as possible in order to minimize its cost and the installation expenses on railroad cars.

The equipment should operate under any type of weather and atmospheric conditions.

It should be compatible with the UIC coupler.

During the transitory period, an auxiliary coupler will be used for coupling with screw-coupler cars.

Operation

All the coupling and uncoupling operations can be made by one single agent without extra difficulty, as compared to the present situation.

The coupling can be performed at speeds between 0.6-9.4 mph.

The coupling can be performed automatically, without human intervention or supervision.

An unintended uncoupling is impossible.

The cars can be safely uncoupled by using a simple unbolting device accessible at both ends and from both sides of the cars.

Upon unbolting, the following functions are realized:

1) The heads remain unbolted until separation of the cars.

2) The heads will then be maintained in a position forbidding coupling.

On both sides of the car the unbolting device should be easy to reach and to operate.

The uncoupling should be effective under traction strengths of approximately 6,600 lbs.

The coupler should be protected against the fall of materials.

The space (Berne rectangle) presently available for the operation of the screw coupler should be maintained if possible.

Dimensions

The principal dimensions of the coupler should be the following:

1) width of the suspension system	11.8 in. 13.8 in. maximum
2) maximum height of suspension system	11.8 in.
3) operation range (maximum distance between the head and the car axis)	8.3 in.
4) coupling range (lateral gathering range between the axis of cars to be coupled)	
a. between automatic coupler cars	8.7 in.
b. between a simplified coupler car and a UIC coupler car	7.9 in.
5) coupling range (vertical gathering)	5.5 in.
6) centerline of coupler above top of rails	41.1 in. maximum 37.4 in. minimum
7) traction resistance (strength in draft)	220,000 lb
8) minimum compression resistance (strength in buffs)	264,000 lb

Bibliography Reference No.	Retrieval Source No.	Data Source and Reference
451*		Punwani, S.K., "The Estimation of Potential Benefits from Improved Operations with Advanced Coupling Systems", 1974 Proceedings of 11th Annual Railroad Engineering Conference, pp. 61-67.

This article introduces the topic of advanced coupling systems with a pictorial review of couplers and air line connectors. It includes tabular summaries of mechanical characteristics suggested by state-of-the-art systems and characteristics of train air lines.

One figure used in the article itemizes tasks to be accomplished by a potential contractor for work on advanced couplers. Another figure lists twelve factors in the potential benefits of advanced couplers.

Network analysis is suggested as a tool for operations planning and the writer further proposes that railroad operations need to be modeled and sampling plans developed to quantify essential elements.

B.3 PATENT FINDINGS

Reference No.	Patent No.	Patent Title
603	3633762 Class 213 Subclass 1.3	Automatic Service Conduit Connector Devices for Railway Vehicle Couplings

Purpose: To automatically connect the service conduits as the cars are coupled.

Concept: This invention relates to service conduit connections for the Willison type coupler. There is a mechanical level system which provides for the final interengagement of the connectors after the frontal impact between coupling heads.

610	3387715 Class 213 Subclass 1.3	Retractable Trainline Connector Apparatus

Purpose: To provide a connector means to automatically connect trainlines.

Concept: The connector is to be carried by a railways vehicle coupler. The service line connector is retractable and moves forward to connect with a mating service line when the carrying couplers move into coupling engagement. For use with "F" or Willison type couplers.

611	3387714 Class 213 Subclass 1.3	Retractable Trainline Connector Device

Purpose: To provide automatic connection of train service lines without relative movement of the connecting members even though there is considerable movement of the coupled couplers.

Concept: Carried on a railroad vehicle coupler. The service lines are retracted and covered until the couplers engage.

Reference No.	Patent No.	Patent Title
650	3224601 Class 213 Subclass 75	Mechanism for Automatically Uncocking and Recocking Automatic Couplings for Railway Vehicles.

Purpose: To provide an automatic uncocking and recocking mechanism for automatic couplings.

Concept: The actuating pawls are fixedly mounted and project into the loading gauge over the vertical height without reaching the area swept by the rolling elements of the car. A control cross element is mounted on the car chassis and is restrained by a stabilizing device. Rotation of the cross element effects the opening and closing of the coupler; the stabilizer prevents accidental shifting of the moving parts of the mechanism due to accidental impact.

670	3854597 Class 213 Subclass 76	Automatic Hose Connector for Railway Cars

Purpose: Automatically connect the train brake line concurrently with the coupling operation of the cars.

Concept: Mechanism delays locking and sealing of air hoses automatically until the cars are effectively coupled together. Mechanism consists of mating head beneath car coupler supporting hose connector supported in a normal, aligned position and provided with a conventional pin and gathering-funnel arrangement for guiding the head into engagement with the counterpart mating head.

671	3812980 Class 213 Subclass 76	Valve Means for Railway Car Train Line

Purpose: Actuate air lines from either side of car equipped with either conventional draft gear or end of car cushioning device.

Reference No.	Patent No.	Patent Title

car's brake line and differentiate between intentional and accidental uncoupling so as to either close the line to prevent braking or opening the line to produce braking.

Concept: Valve mechanism, involving pneumatic piping, circuit using air supply of brake line and air-actuated control valve and two pilot valves, whereby one pilot valve is responsive to coupling and thereby actuates control valve to open the brake valve and the other pilot valve is responsive only to intentional uncoupling and thereby actuates the control valve to close the brake valve.

686	3599665 Class 213 Subclass 76	Automatic Air Line Connection System

Purpose: Automatically connect and disconnect air brake lines of two rail cars without requiring manual opening and closing of brake pipe anglecocks.

Concept: Device attached in a fixed position to top of coupler holds air line and connects with air line held by similar device on another car. Upon uncoupling, normally closed disconnect valves open to provide flow for brake air between cars and a second, spring-actuated valve that is manually operated from the side of the car and used to close first valve (and thereby stop flow of brake air) upon uncoupling of cars.

702	3854599 Class 213 Subclass 76	Railway Coupler

Purpose: To reduce the number of incidences of lateral and vertical passed couplers.

Concept: Provision of an upstanding rib projecting outward from a coupler housing to inhibit twist-out of the knuckle under derailment conditions.

Reference No.	Patent No.	Patent Title
703	3774776 Class 213 Subclass 100	Universal Automatic Coupler

Purpose: A design of a universal automatic coupler.

Concept: An automatic coupler comprising a shank and coupler head. One member is a guide member, the other is a locking and guiding member.

705	3655066 Class 213 Subclass 100	Railway Car Coupler

Purpose: To increase the horizontal gathering range of a hook type coupler.

Concept: The coupling hook and inboard projections each have a forwardly extending tapered portion defining first and second lateral alignment. The invention provides a more compact arrangement of guiding surfaces for improving the gathering range.

740	3127023 Class 213 Subclass 103	Railway Car Coupler

Purpose: Automatic coupler transmitting draft and buff forces, eliminating slack between mated couplers, to be used in place of hook and screw type couplers presently used in some countries.

Concept: One piece cast coupler, head of coupler having upper and lower sections that define a "throat" to receive a lock of a mated coupler, the sections extending at 45 degree angles from a horizontal plane in the form of wings to provide gathering and buff force capabilities. The unlocking mechanism includes a rotor manually operated by a rod that is used to move the lock to a lockset position.

Reference No.	Patent No.	Patent Title
761	3717261 Class 213 Subclass 110	Car Coupler

Purpose: Provide a means for always keeping knuckle of uncoupled coupler in unlocked (open) position.

Concept: Spring assembly device, applied to a coupler as one unit, actuates the knuckle unlocking device when the uncoupling rod is activated or when the plunger, to the device located within the knuckle, is no longer depressed by the knuckle of the mated coupler.

890	3872978 Class 213 Subclass 151	Knuckle Structure for Railway Vehicle Coupler

Purpose: To increase the lateral gathering range.

Concept: The gathering face on the knuckle is in the form of a convex surface of an arc of fixed radius which approximates a portion of an equi-angular spiral. The resultant face of friction and the force normal at any point of contact along the entire length of the convex gathering surface is incapable of turning the knuckle from an open to closed position until the tip of the nose has passed the tip of the mating coupler.

892	3856156 Class 213 Subclass 151	Railway Car Coupler

Purpose: To reduce slack.

Concept: A knuckle type coupler with a modified 10A contour. The pulling face of the knuckle is offset 5/64 inch closer to the front face of the coupler head. The heel and adjacent front face portions of the knuckle are contoured along a smooth compound convex curve to provide a tightenea contour. The inner

Reference No.	Patent No.	Patent Title

side wall of the tail portion adjacent to the throat section is curved with substantial radius to prevent binding during uncoupling.

895	3670901 Class 213 Subclass 151	Car Coupler

Purpose: To increase the gathering range.

Concept: Change in knuckle nose contour to provide a gathering surface that is effective when coupler is open.

900	3606032 Class 213 Subclass 152	Railway Car Coupler

Purpose: To promote vertical and lateral alignment.

Concept: An auxiliary lug is mounted on a shelf carried on the lower portion of the coupler head. The lug has a ramp portion to slidably engage the bottom forward edge of a shelf carried by an opposed mating coupler to permit coupler alignment.

901	3121498 Class 213 Subclass 152	Coupler Knuckle

Purpose: Provide a means for the knuckle coupler head to absorb impact from buffing, thereby eliminating structural failure of the coupler due to buffing.

Concept: Place lugs on coupler knuckle in a manner so that mating a closed-knuckle coupler with an opened-knuckle coupler occurs tangentially, thereby increasing the amount of impact that can be taken without causing damage to the coupler knuckle.

Reference No.	Patent No.	Patent Title
910	3698571 Class 213 Subclass 153	Interlocking Coupler

Purpose: To provide a coupler structure which will prevent a pair of mated couplers from separating by a vertical movement of one with respect to the other. This objective is accomplished if only one of the mated couplers is equipped with the invention.

Concept: A spring loaded dog (latch) is attached to the distal end of a coupler. The dog slips into an opening in an adjacent coupler limiting vertical coupler movement to the vertical height of the opening. The engagement between couplers is maintained and during coupler rotation due to negotiating sharp curves.

912	3637089 Class 213 Subclass 153	Railway Car Coupler

Purpose: To provide a hood for an "F" coupler to afford vertical interlock between two opposed couplers when the "F" coupler is intercoupled with an AAR standard "E" coupler. A secondary objective is to prevent a worn knuckle of an "E" coupler from slipping out of the knuckle receiving access of the "F" coupler.

Concept: An interlock hood is integrally connected to the upper side of the "F" coupler head. The hood has a roof that overlies the vertical recess of the coupler head. The hood does not restrict normal movement of the "E" knuckle with the "F" coupler contour.

913	3073459 Class 213 Subclass 153	Vertically Interlocking Railway Car Coupler

Reference No.	Patent No.	Patent Title

Purpose: To provide a knuckle type of automatic coupler (type "E") with a vertical interlock shelf having a recess for receipt of the lower auxiliary interlock lug of a type "F" coupler to permit intercoupling.

Concept: Coupler shelves afford vertical support for the knuckle of the mating coupler to provide vertical interlock to prevent vertical separation in the event of coupler shank failure or separation of a coupler from the draft rigging of the car.

940	3805968 Class 213 Subclass 159	Brush Uncoupler for Rail Cars

Purpose: To uncouple rolling rail cars without manual release of side levers.

Concept: A cylindrical bristle brush is engaged with the handle of the uncoupling lever. The brush is rotated at a speed and in a direction so that the bristles move the handle to uncouple.

943	3491899 Class 213 Subclass 159	Fluid-Operated Uncoupling Mechanism

Purpose: To provide a fluid-operated uncoupling mechanism which is mechanically connected to the longitudinally swingable part of the coupler's locklift assembly to prevent accidental uncoupling.

Concept: A mechanism applied to an "E" coupler having a fluid pressure responsive actuator mounted on the head and mechanically connected to the locklift assembly of the coupler. This will enable the coupler to be uncoupled by fluid pressure and will also positively lock the coupler against accidental uncoupling.

Reference No.	Patent No.	Patent Title

A spring-returned piston is connected to an operating shaft. On advance of the piston a crank swings the assembly in an uncoupling or locklifting direction.

The coupler can be uncoupled mechanically by applying a turning tool to the operating shaft.

960	3834554 Class 213 Subclass 166	Uncoupling Lever for Railroad Cars with Standard Draft Gear Cushioning

Purpose: To provide an uncoupling lever assembly designed for use with cars with standard draft gear cushioning that avoids a substantial amount of lateral movement of the lever assembly handle. The lever is interchangeable between cars and may be applied to and removed from the car without uncoupling the car.

Concept: Prior to this invention, uncoupling levers on cars with draft gear cushioning have been rigid against extension and lengthwise contractor of the operating rod to the car end. This lever has an elongated rectilinear bar in which the handle section is swingably mounted on the car end by a special ore lock pivotal connection which holds the handle section against significant shifting movement under coupler side swing and impacts.

1020	3854598 Class 213 Subclass 211	Automatic Unlocking Device for Rolling Stock Couplers

Purpose: To automatically unlock by lifting fastening cotter pins.

Concept: A base is installed at the side of a track and a boom mechanism is attached. The boom mechanism is composed of parallel links moveable along the track and tilting towards the track. A robot is hung from the boom which is lowered between cars to pull the cotter pins.

Reference No.	Patent No.	Patent Title
1042	3532228 Class 213 Subclass 212	Electronic Control and Surveillance System for Railway Trains

Purpose: Selectively control electronically by a master unit at a locomotive cab couplers or other automatically operable equipment and information supplying devices of one or more cars making up a train.

Concept: Electronic system that controls the operation of automatic devices (such as couplers) by electronically activating air cylinder units and obtains information from each car through the use of a master system (in locomotive) that hooks up with slave units in individual cars.

1043	3690469 Class 213 Subclass 212	System for Automatically Releasing Connection Between Cars in Train

Purpose: Automatically uncouple any desired car of a train from the locomotive of the train.

Concept: A line providing electrical and pneumatic controls from the locomotive that disconnects any desired car of a train by the force of air under pressure.

1044	3743111 Class 213 Subclass 212	System for Disconnecting Any Desired Car in a Train

Purpose: Uncouple any desired car of a train from locomotive.

Concept: Actuating air supply line and instruction air are connected to a compressed air source in a locomotive and extends through train whereby operator in locomotive manipulates on-off valve by the number of times corresponding to the number of the car to be uncoupled, which then supplies high pressure air to

Reference No.	Patent No.	Patent Title

air conduits in the specific car which actuates a coupler unlocking device.

1045	3724680 Class 213 Subclass 212	Remote Control System for Automatic Car Uncoupling Device

Purpose: Remotely (from locomotive) perform control functions (such as automatic uncoupling) on individual railcars.

Concept: Train line circuitry (including stepping switching, relays, and solenoid valves) used to remotely operate from locomotive control functions such as automatic uncoupling of selective cars throughout a railway train.

1046	3245553 Class 213 Subclass 212	Fluid-Operated Uncoupling Mechanism

Purpose: Provide an improved fluid-operated uncoupling mechanism which can be adapted to either manual or automatic operation, and requires no operating slack.

Concept: Automatically or manually (by means of conventional operating rod) operated device that opens knuckle of coupler by means of a fluid-operated lock actuator mounted on the coupler and mechanically connected to the lock.

1061	3227289 Class 213 Subclass 219	Coupler Operator for Railway Cars

Purpose: To present a new and improved coupler lever to accomodate significant longitudinal and some rotational movement of the car relative to the car frame.

Concept: The coupler level is equipped with an impact absorbing device to allow for relative movement between the center

Reference No.	Patent No.	Patent Title

sill of the car and the car frame.

The lever is operable from the side of the car.

1063	3117677 Class 213 Subclass 219	Railway Car and Coupling Device

Purpose: Provide a means for a person to manually uncouple a coupler mounted in a sliding sill underframe, regardless of the length that the coupler is extended from the underframe.

Concept: Attach a rod with a lever to the end of the car that runs parallel to the end of the car. Hook the end of this rod to an arm attached to the rod running parallel to the shank of the coupler that mechanically unlocks the knuckle of the coupler when the lever of the rod that is parallel to the end of the car is actuated by a person.

1070	3249066 Class 105 Subclass 3	Actuating Device for Combined Wheel Guidance and Axle Orientation in Railroad Vehicles

Purpose: Provide a means for coupling or uncoupling two European rail cars that have to engage or disengage traction and orientation connections (that control the axle location relative to changes in its axis due to track curvatures).

Concept: A rocker and rod arrangement device disengages the coupling/uncoupling device from the guiding device (basically provided by the two side bumpers).

1100	3642149 Class 213 Subclass 15	Coupler-Positioning Device for Railroad Car Couplers

Purpose: To position the coupler--center of track.

Concept: A swing lever is positioned between the coupler

Reference No.	Patent No.	Patent Title

and the car truck. Cable structures extend between the respective ends of the swing lever and the coupler shank.

1101	3809251 Class 213 Subclass 15	Coupler Positioning Device for Sliding Sill Cushion Underframe Cars

Purpose: To position a coupler in the center of the track.

Concept: For use with sliding sill cushion underframe cars in which the coupler is connected to either end of a command or swing lever by an uncushioned cable connection. Cables are tensioned against the action of the shock absorber to provide the desired flexion free linkage between the swing lever and the coupler for coupler positioning.

1140	3450271 Class 213 Subclass 75TC	Railroad Coupling

Purpose: A coupler for use in rapid transit system.

Concept: An electromagnet is located at the outer end of a piston rod of a double acting pneumatic cylinder. The cylinder absorbs the shock of the coupling impact and also draws the cars together.

1160	3646498 Class 339 Ref to 213 Subclass 48- 1.3	Electrical Circuit Control Apparatus

Purpose: To provide an electrical circuit control apparatus suited for railroad cars which eliminates live exposed electrical contacts when railroad cars are uncoupled.

Concept: A spring loaded contact pin assembly for making

Reference No.	Patent No.	Patent Title

and braking electrical circuits. This invention reduces the danger of electrical shock and susceptibility to damage.

APPENDIX C

SIGNIFICANT COUPLER CONCEPTS

C.1 DESCRIPTION OF FUNCTION CODES

1) IA1. Automatic air line connection with coupling
2) IA2. Provide second air line system
3) IA3a. Automatically open air valves upon coupling
4) IA3b. Automatically close air valves upon intentional uncoupling
5) IA3c. Automatically open air valves upon unintentional uncoupling
6) IB1. Improve integrity of air seal by lowering leak rates or gasket wear rates
7) IB2. Improve hose reliability regarding breakage, damage, or failure
8) IB3. Reduce hose and/or glad hand maintenance costs
9) IIA1. Improve lateral gathering range of mechanical coupling
10) IIA2. Improve vertical gathering range of mechanical coupling
11) IIA3. Provide positive locking of mated couplers
12) IIB1. Increase speed range at which positive coupling can be made
13) IIB2. Reduce free slack of mated couplers.
14) IIB3. Provide vertical interlock for mated couplers
15) IIB4. Absolutely entrap broken coupler
16) IIC1. Maintain position of coupler to center of car
17) IIC2. Reduce contour angling capability of coupler
18) IIC3. Maintain position of coupler to center of tracks
19) IID. Reduce required coupler maintenance
20) IIIA1. Improve uncoupling capability through the use of an alternate side lever
21) IIIA2. Improve uncoupling capability through the use of a push button release on side of car

22) IIIA3a. Provide means of automatically uncoupling from within train

23) IIIA3b. Provide means of automatically uncoupling from point external to train

24) IIIA4. Provide means to uncouple in draft

25) IIIB1. Improve recoupling capability by automatically opening knuckle at uncoupling

26) IIIB2. Improve recoupling capability through other means

27) IVA1. Automatically control brake with time delay set provisions upon intentional uncoupling

28) IVA2. Automatically control brake with emergency set upon unintentional uncoupling

29) IVB1. Provide electric train line system with automatic connection make and break

30) IVB3. Provide electric train line system with automatic sequencing of contactors

31) IVB4. Provide electric train line system with full environmental protection of contactors

32) IVB5. Provide electric train line system having train sensing capabilities

33) IVB6. Provide electric train line system having train control capabilities

34) IVC. Improve operational safety of coupler system

C.2 DESCRIPTIONS OF CONCEPTS

Concept 6a: GRIMESTHROPE ASF/V COUPLER

Primary Bibliography Reference No.: 6

Related Reference Number(s)

Description of Concept	
Compatibility with AAR Type "E" Coupler:	Grimesthorpe ASF/V coupler (rigid type, with horn-funnel, hinged hook); Symetrical pyramid shaped horn; Fits opposite recessed funnel; Hinged locking hooks interlock; Rigid coupling (cast finish); Top overlapping flanged and side; Tongue/groove fittings; Draft strength/coupler weight; spring loaded locking hooks automatically engage opposite horn at coupling. Automatic air connection and "knuckle always open.
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- ± 5" (2.5 times standard lateral gathering range).
*IIA2.	- ± 5" (3.3 times standard vertical gathering range).
*IIA3.	- Positive locking.
IIB1.	- 0.125" slack (0.16 times standard). Economical cast coupling face.
*IIB2.	- Vertical interlock.
*IIB3.	- Absolute entrapment of broken coupler.
*IIB4.	** Light duty design with weight ratio = 385 at draft pull = 308,000 lbs.
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
*IIIB1.	
IIIB2.	- Always open upon uncoupling (like open knuckle).

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	Improved safety.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 6b: CONCEPT GRESHAM AND CRAVEN LTD. AIR CONNECTOR

Primary Bibliography Reference No.: 6

Related Reference Number(s)

Description of Concept

Compatibility with AAR Type "E" Coupler:		
1. Can be added to Type "E"		Automatic air connection (within the head of rigid coupler) located on centerline and beneath coupler head.
2. Requires modification of Type "E"		
3. Requires head adapter for Type "E"		
4. Incompatible with Type "E"	X	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	
IIA2.	** Ball type air closure connection (spring loaded and approximately 5-1/2" O.D.) would be susceptible to clogging from foreign particles. In addition, is rather large and bulky.
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 8: SW COUPLER POSITIONING DEVICE

Primary Bibliography Reference No.: 8

Related Reference Number(s) 41,517

Description of Concept

Mechanical linkage-roller type (for existing cars;
Automatic positioning through manual linkage;
Reduced maintenance.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	** Six element mechanical linkage with override springs to position coupler while allowing coupler to swing to double the positioning angle. Requires approximately 1,200 lbs. wheel flange force during maximum positioning (complicated linkage system).
IIB1.	
IIB2.	
IIB3.	
IIB4.	- Would eliminate approximately 90% of coupler bypass.
IIC1.	
IIC2.	** Difficult to position manually.
* IIC3.	
* IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Improves safety by eliminating approximately 90% of bypass.
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 9: SW 800 COUPLER

Primary Bibliography Reference No.: 9

Related Reference Number(s) 517

Description of Concept

Rigid, horn-funnel, hinged hook type with automatic air and electrical connections (symmetrical, pyramid shaped horn/funnel;
Uncoupling cam released pneumatically;
Locking hooks forced apart by cam wedge force;
Spring loaded locking hooks automatically engage opposite horn at coupling;
Automatic air connections (within the head of rigid coupler);
Electrical connector suspended below coupler;
Environmental cover cammed aside by force of the mating coupler;
Final electrical contact is made by air inflation of a diaphragm which moves pins forward;
Automatic air connection and locking hook always open.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	- Ball type connection should have good fit and function due to tight fit of coupler spring loaded, compressed rubber air seals.
* IA2.	- Second air line system available.
* IA3a.	** Air valve control (part of Walton system - see Biblio. No. 254) switching may have maintenance problems as result of plug-up of solenoid valves due to rusting of iron cores.
* IA3b.	- Aligning pins free air connector of stress forces.
* IA3c.	- Lack of glad-hand air seal and hose lateral movement would improve integrity and reliability and reduce maintenance.
* IB1.	
* IB2.	
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	- (Larger version of proven subway coupler).
* IIA2.	- Lateral = ± 5" (2.5 times standard gathering range).
* IIA3.	- Vertical = ± 5" (3.0 times standard gathering range).
* IIB1.	- Hinged locking hooks have positive spring loaded interlock by direct action of compression of guide pins on coupler face.
* IIB2.	- Machined rigid face = "no" free slack.
* IIB3.	- Aligning pins and dowels plus locked hooks gives good vertical interlock.
* IIB4.	- Pin/dowel fit plus interlocking spring loaded hooks achieves absolute entrapment and gives reduced control angling.
* IIC1.	- Reduced maintenance of air hoses etc. from self-contained features.
* IIC2.	
IIC3.	
* IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
* IIIA1.	- Allows remote uncoupling release from within train.
* IIIA2.	- Provides good reliability against unintentional uncoupling and provides uncoupling capability in draft.
* IIIA3a.	- Always open at uncoupling (like open knuckle).
* IIIA3b.	
* IIIA4.	
* IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
* IVA1.	** Electrical contacts may be subject to excessive wear from environmental grime from roadbed.
* IVA2.	** Cover subject to damage and malfunction due to impact forces of camming action during coupling.
* IVB1.	** Potential for malfunction from a jamming and rupture of diaphragm or to stress aging and hardening of diaphragm.
* IVB3.	- Improved safety.
* IVB4.	
* IVB5.	
* IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 22: DRESSER AUTOMATIC/PNEUMATIC COUPLING SYSTEM

Primary Bibliography Reference No.: 22

Related Reference Number(s) 434, 451, 605, 517

Description of Concept

Automatic air connection (coupler mounted, spread-wing with butt line connections);
Automatic connection with coupling;
Automatic operation of air valves;
Improved performance.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	** Careful analysis and test would be required of spread-wing design to assure adequate wear strength and wear characteristics.
* IA2.	- Coupling mechanical forces operate a push rod and pilot line which opens the air line valve at coupling (no added movements).
* IA3a.	- Lifting the uncoupling lockset lever operates a valve which pressurizes a pilot line to close train air line valve (no added movements).
* IA3b.	- Unintentional uncoupling (no operations of uncoupling lever) leaves train air line valves open to set brakes.
* IA3c.	- Less air leakage, improved line seal, improved safety.
* IB1.	- Valve controls would add mechanical and maintenance complexity but a minimum of sensitive control circuits.
* IB2.	- System provides for "mixed" coupling without any mechanical changes.
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
* IVA2.	- Improved safety.
* IVB1.	
IVB3.	- Air connector can provide second air line <u>or</u> a small electrical connection system.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 25: S-W "L-C" COUPLER

Primary Bibliography Reference No.: 25

Related Reference Number(s) 517

Description of Concept

Long car coupler (72" shank with swivel butt and vertical swivel point midway to "F" head);

Interlocking head.

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: IA1., IA2., IA3a., IA3b., IA3c., IB1., IB2., IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: *IIA1., *IIA2., *IIA3., IIB1., *IIB2., *IIB3., *IIB4., IIC1., *IIC2., IIC3., *IID.

- Gathering range, locking, free slack, interlock and entrapment improvements through use of "F" coupler head.

** Longer (72") shank and "F" (interlocking) head result in reduced contour angling.

- Vertical pivot allows greater head vertical movement w/o increasing jackknifing possibility.
  Total lateral movement = ± 16-1/4" (32-1/2").
  total vertical movement = + 2-3/4", -5" (7-3.4").

** Manual centering would not aid normal switching operations with this heavy (967 lbs.) head and shank, some mechanical aid would be needed to achieve centering where required.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., * IVC.

- Reduced probability of lifting trucks on curves, and therefore, reduced derailment probability.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 26: CONTROLLED SWIVEL "E" COUPLER

Primary Bibliography Reference No.: 26

Related Reference Number(s) 517

Description of Concept

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

Limited centering and contour angling capability;

Reduced contour angling.

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	- Self centering achieved as follows: Angularity above 4°, draft gear is depressed and uncoupled gear returns to center when lateral force is removed. (4° = 2.0" offset for 28.5" coupler and 4.2" for 60" coupler). Angularity above 4° expected on 10-20% of operating time.
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	- Maximum angularity of 15° (for 60" coupler) as compared to standard of 7°, results in less contour angling on curves.
* IIC1.	
* IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	- Reduced contour angling lowers derail probability and increases safety.
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 27: DRESSER RAPID TRANSIT COUPLER

Primary Bibliography Reference No.: 27

Related Reference Number(s) 448, 517, 606, 750

Description of Concept

Smaller version of SW 800 (see also Bibliography Reference Number 9).

Electro-pneumatic switching unit operates:
(1) Train air valves (at coupling and uncoupling).
(2) Make/break of electrical contacts.
(3) Car uncoupling lever.
(4) Centering device (at coupling and uncoupling).

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	Small version of SW-800. See Bibliography Reference Number 9.
*IA2.	
*IA3a.	
*IA3b.	
*IA3c.	
*IB1.	
*IB2.	
*IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	
*IIA2.	
*IIA3.	
IIB1.	
*IIB2.	- Pneumatic actuated (at uncoupling) rubber boots on each side of shank to achieve self-centering.
*IIB3.	
*IIB4.	
*IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	** Achieves self-centering in uncoupled state (some question of permanent retention of air in expanded rubber boots for self-centering in extreme environments).
IIIA2.	
*IIIA3a.	
IIIA3b.	
*IIIA4.	
*IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
* IVA1.	- Achieves automatic brake control at uncoupling (assuming electrical power available).
IVA2.	- Achieves train control for air valves, electrical contacts, uncoupling and centering.
* IVB1.	
* IVB3.	
* IVB4.	
IVB5.	
* IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 31a: SW COUPLER POSITIONING DEVICE

Primary Bibliography Reference No.: 31

Related Reference Number(s) 517

Description of Concept

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

Hydraulic master-slave type (for existing cars);

Automatic positioning through hydraulic master-slave system.

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: IA1., IA2., IA3a., IA3b., IA3c., IB1., IB2., IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., IIC1., IIC2., *IIC3., *IID.

- Truck bolster movement transmitted to hydraulic cylinder "master" through flexible hose to a "slave" hydraulic cylinder to move coupler head.

** May be difficult to position manually.

- Would eliminate estimated 90% of coupler bypasses.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., * IVC.

See Bibliography Reference Number 8.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 31b: SW COUPLER POSITIONING DEVICE

Primary Bibliography Reference No.: 31

Related Reference Number(s) 517

Description of Concept

Hydraulic direct guided 136" coupler with wide mouth swing draft sill (for new construction); Automatic positioning through hydraulic direct guiding of long coupler.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	X
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	- Two hydraulic cylinders at outer edge of truck bolster directly move the coupler shank, simple system should be very reliable.
IIA3.	- 136" coupler length reduces contour angling (would need "F" type locking head).
IIB1.	- Would eliminate approximately 90% of coupler bypasses.
IIB2.	** Heavy swinging draft sill would be very difficult to position manually (if required to mate with a non-equipped car).
IIB3.	
IIB4.	
IIC1.	
* IIC2.	
* IIC3.	
* IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	See Bibliography Reference Number 8.
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 33: EUROCOUPLER 68

Primary Bibliography Reference No.: 33

Related Reference Number(s) 46, 301, 303, 308, 309

Description of Concept

Integral, rigid coupler with automatic air connection and automatic operation of air valves;
Semi-rigid, open faced, spread wing, hinged hook type with positive locking and reduced free slack;
flexible pull clutch (air cylinder operated) releases wedge lock to allow hinged locking hook to be forced open by slant rear edge of rating coupler;
Hinged environmental cover is wedged open at coupling;
Round electrical connector with pin/socket mating.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	** Air connection depends on rubber compression held by coupler locking hook which has slack of at least 0.04" in all directions.
* IA2.	
* IA3a.	** Electric solenoid operation of air valve subject to possible malfunction from rust or contamination.
IA3b.	
IA3c.	
* IB1.	
* IB2.	
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	** Spring loaded movable hook locks on outside of rear slant face of fixed knuckle (depending on rust or grime build-up, bounce-back may occur before final locking).
IIA2.	
* IIA3.	
IIB1.	** Machined movable pieces and mating faces gives approximately 0.04" free slack (complicated system).
* IIB2.	
* IIB3.	
* IIB4.	
IIC1.	
* IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	- Air cylinder offers good remote uncoupling capability.
* IIIA3a.	
IIIA3b.	** Electric solenoid not yet successful indicates excessive force may be required to release wedges for uncoupling.
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	** Cover/wedge design needs careful review for adequacy against damage and malfunction.
IVA2.	
* IVB1.	** Round connector limits number of circuits.
IVB3.	
* IVB4.	** Rigid pin/socket type contacts subject to damage and malfunction due to free slack movements of coupler.
IVB5.	
* IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 36: BRITISH WEDGLOCK COUPLER

Primary Bibliography Reference No.: 36

Related Reference Number(s)

Description of Concept

Rigid, flat faced, hinged hook with locking from camshaft driven wedge;
Integral automatic air connection and automatic operation of valve (international only).
Electrical signal from CPB operates electro-pneumatic switch so air rotates a camshaft for unlocking coupler;
Environmental cover uses nylon hinges;
Butt type, spring loaded, brass contacts in electrical connector;
Automatic air connection and locking hook always open.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: *IA1., *IA2., *IA3a., IA3b., IA3c., *IB1., *IB2., *IB3.

** Air connection depends on rubber compression held only by coupler locking.

- Air valves operated by air or manual camshaft (same operation as automatic coupler locking) should achieve very reliable operation.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., *IIA3., IIB1., *IIB2., *IIB3., *IIB4., IIC1., *IIC2., IIC3., IID.

** Light duty rapid transit design.

** No automatic locking unless positive action from both air and electrical signals.

- Hook wear is taken up by camlock wedge action.
- Positive locking from wedge retained even with subsequent air loss.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., *IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

- Camshaft unlock would give positive rotating (leveraged) control of uncoupling.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., * IVB1., IVB3., * IVB4., IVB5., * IVB6., * IVC.

- Free movement (and reliability) of environmental cover as improved by non-binding hinges.

** Brass contacts (not silver faced) are subject to low contact reliability with use.

- Improved safety.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 41a: HOLLAND POSITIONING DEVICE

Primary Bibliography Reference No.: 41

Related Reference Number(s) 512

Description of Concept

Direct positioning control from trucks through rod-lever-cable linkage.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	- Simple, direct connected (rod-lever-cable) positioning of coupler from trucks (permanent connection).
IIB1.	
IIB2.	** User report of rapid deterioration from normal wear and vibration.
IIB3.	
IIB4.	
IIC1.	
IIC2.	
* IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	- Improved safety by reducing bypass probability.
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 41b: EVANS CENTERING DEVICE

Primary Bibliography Reference No.: 41

Related Reference Number(s) 512

Description of Concept

Direct centering by opposing horizontal spring below shank and bell housing.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	** Manual disengagement difficult unless coupler is centered.
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
*IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 41c: EVANS POSITIONING DEVICE

Primary Bibliography Reference No.: 41

Related Reference Number(s) 512

Description of Concept

Direct positioning control from trucks through a double-acting side spring moving a lateral spring loaded shank carrier.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	** Reliability suspect due to high leverage movements needed under high friction load conditions.
IIB3.	
IIB4.	
IIC1.	
IIC2.	
* IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	See Bibliography Reference 41a Category IV.
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 41d: STANRAY CENTERING DEVICE

Primary Bibliography Reference No.: 41

Related Reference Number(s) 446, 507

Description of Concept

Compatibility with AAR Type "E" Coupler:		
1. Can be added to Type "E"	X	Single coil spring type.
2. Requires modification of Type "E"	X	
3. Requires head adapter for Type "E"		
4. Incompatible with Type "E"		

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	- For use on standard or high-cube cars.
IIB1.	
IIB2.	- Low maintenance and inoperability rate.
IIB3.	
IIB4.	** Some problem to manually disengage if coupler not on centerline.
*IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 41e: STANRAY CENTERING DEVICE

Primary Bibliography Reference No.: 41

Related Reference Number(s) 446, 507

Description of Concept

Double leaf spring type.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	** High damage susceptibility when used on high-cube cars.
IIA3.	
IIB1.	** Relatively high maintenance and inoperability rate.
IIB2.	
IIB3.	** Some problem to manually disengage if coupler not on centerline.
IIB4.	
*IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 41f: STANRAY CENTERING DEVICE

Primary Bibliography Reference No.: 41

Related Reference Number(s) 446, 507

Description of Concept

Double coil spring type.

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions

IA1.
IA2.
IA3a.
IA3b.
IA3c.
IB1.
IB2.
IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions

IIA1.
IIA2.
IIA3.
IIB1.
IIB2.
IIB3.
IIB4.
*IIC1.
IIC2.
IIC3.
IID.

** Limited application for mid-size cars.

** Damage problems and higher cost caused manufacturer to remove from production.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions

IIIA1.
IIIA2.
IIIA3a.
IIIA3b.
IIIA4.
IIIB1.
IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions

IVA1.
IVA2.
IVB1.
IVB3.
IVB4.
IVB5.
IVB6.
IVC.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 41g: STANRAY CENTERING DEVICE

Primary Bibliography Reference No.: 41

Related Reference Number(s) 446, 507

Description of Concept

Swing type

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	** Limited application only on standard cars.
IIA2.	** Difficult to operate manually.
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
* IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 45a: SNCF DOUBLE-LIP SEAL AIR CONNECTOR

Primary Bibliography Reference No.: 45

Related Reference Number(s)

Description of Concept

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	
* IA2.	
* IA3a.	- Double-lip (concentric seals) would hold sufficient seal for both vacuum and pressure.
* IA3b.	
IA3c.	** Air valves operated by vacuum differential (approximately 2 psi) applied to quick release valves in each car for simultaneous bleed of air lines for switching. (Holding the required vacuum and quick vacuum differentials doubtful for a long train system.)
* IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 45b: SNCF VACUUM BRAKE CONTROL SYSTEM

Primary Bibliography Reference No.: 45

Related Reference Number(s)

Description of Concept

Centrally operated brake release of all cars through quick release valves operated on approximately 2 psi vacuum.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
* IVA1.	- System to bleed all cars simultaneously in preparation for hump switching.
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
* IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 45c: KHOEPS ELECTRICAL CONNECTOR

Primary Bibliography Reference No.: 45

Related Reference Number(s)

Description of Concept

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
* IVB1.	** Contact life satisfactory only when connection was made without load.
IVB3.	
* IVB4.	** Environmental caps over electrical contacts not totally successful.
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 47a: SIMPLIFIED U.I.C. COUPLER - FRENCH

Primary Bibliography Reference No.: 47

Related Reference Number(s)

Description of Concept

Sliding rods release uncoupling mechanism;

Locking bolts drop into place ready for automatic recoupling;

Semi-free, open-face, spread claw, fixed knuckle, discontinuous coupling movement modified Willison.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions
IA1.
IA2.
IA3a.
IA3b.
IA3c.
IB1.
IB2.
IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions
*IIA1.
IIA2.
IIA3.
*IIB1.
IIB2.
IIB3.
IIB4.
*IIC1.
*IIC2.
IIC3.
IID.

(Interchange with Willison)

- Lateral gathering = 17.4" total (4.35 x standard) - however, is not balanced around centerline.

** Discontinuous lateral coupling movement (0.8") would tend to create damage problems for integral air or electrical connectors.

** Coupler "blocking" occurs at coupling angle over 9° (a separate buiding horn would possibly correct).

- Vertical and horizontal centering with direct attached springs (two vertical on each side, two horizontal outside of shank).

** Centering disengagement device is damage prone.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions
IIIA1.
IIIA2.
IIIA3a.
IIIA3b.
*IIIA4.
*IIIB1.
IIIB2.

- Uncoupling in draft is possible up to approximately 8,800 lbs. draft force.

** Corrosion or environmental build-up can prevent gravity drop of locking bolts.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions
IVA1.
IVA2.
IVB1.
IVB3.
IVB4.
IVB5.
IVB6.
IVC.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 47b: PENDULUM SELF CENTERING SYSTEM

Primary Bibliography Reference No.: 47

Related Reference Number(s)

Description of Concept

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X	Simplified U.I.C. coupler - pendulum self-centering system.
2. Requires modification of Type "E"		
3. Requires head adapter for Type "E"		
4. Incompatible with Type "E"		

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	- Shank rides on a swinging bench supported on each side by hanging bars - gives pendulum or gravity centering.
IIB2.	
IIB3.	
IIB4.	** Potential problem of damaging harmonic swings under lateral vibration.
* IIC1.	** Safety problem in hand centering cars coupled on a curve.
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 52: TYPE "F" COUPLER WITH TOP SHELF

Primary Bibliography Reference No.: 52

Related Reference Number(s) 38, 54, 405, 455

Description of Concept

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	- Gives full vertical entrapment for mated "E" or "F" couplers.
IIA2.	
IIA3.	
IIB1.	
IIB2.	
* IIB3.	
* IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Would reduce tank car punctures an estimated 60%.
IVA2.	- Prevent vertical separation.
IVB1.	** Still has possibility for high rupture probability (if subject to tank car impact) due to sharp interlocking lug.
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 54: TYPE "E" COUPLER WITH TOP AND BOTTOM SHELF

Primary Bibliography Reference No.: 54

Related Reference Number(s) 38, 52, 405, 455

Description of Concept

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	- Gives full vertical entrapment for mated "E" or "F" couplers.
IIA3.	
IIB1.	
IIB2.	
*IIB3.	
*IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	- Same advantages as type "F" (Biblio 5.2) without sharp lug problems.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 254: WALTON "ELECTRO-PNEUMATIC" CONTROL SYSTEM

Primary Bibliography Reference No.: 254

Related Reference Number(s) 516

Description of Concept

Also see data sheets following.

Operation of air valves is sequenced automatically as part of electro-pneumatic control system started by (1) coupling process (2) pushing uncoupling button or (3) manual, air valve operation;
Uncoupling initiated by (2) electric signal from control car (2) electric switch at growth level or (3) manual lever on top of coupler;
Train brakes set automatically (on cars being set-off) and electrical connections completed automatically. Remote uncoupling and train air valve control. (See next page for full system description.)

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	- Provides automatic operation of air valves for both coupling and uncoupling sequences.
IA2.	
* IA3a.	
* IA3b.	
* IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	- Provides automatic uncoupling release from within train (cab of switching car), external (outside of switching car) or manual backup at coupler head.
* IIIA2.	
* IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Full automatic electrical and brake control.
* IVA2.	** System requires a fixed minimum residual car air pressure to operate without delays.
* IVB1.	** System requires definite maintenance at frequent intervals.
* IVB3.	- Improved safety (remote uncoupling and valve control).
* IVB4.	
IVB5.	
* IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

SUPPLEMENTAL SYSTEM DESCRIPTION FOR BIBLIOGRAPHY REFERENCE NO. 254

The basic operating sequence for the Walton "Electric-Pneumatic" control sytstem (as affecting the cars being coupled/uncoupled) is:

Coupling Sequence

1) Electrical box covers are levered open to expose contacts.

2) Permanently extended circuit pins make contact.

3) Coupling switch is closed by complete insertion of the coupling locking hook.

4) Coupling solenoid is actuated and instigates the following functions (some with time delay).

(a) Open pilot air line valves.

(b) Open train air line valves.

(c) Open valve to provide air to electric coupler box piston (which moves the contact block forward to project the retracted contact pins to extended position in full contact).

(d) Exhaust air from centering device cylinders to disengage automatic centering.

5) Appropriate system indicators display in control cab.

Uncoupling Sequence

1) Uncoupling signal (electric switch from control cab or ground level of switching car) is started.

2) Uncoupling solenoid is actuated and instigates the following functions (some with time delay).

(a) Apply air to centering device cylinders.

(b) Close train air line valves.

(c) Exhaust air to electric coupler box piston (which allows a spring loaded retraction of contact block and disconnection of all contact pins except permanently extended contact pins).

(d) Energize the uncoupling cylinder to mechanically disengage the coupler locking hooks.

3) Cars pull apart.

4) Permanently extended circuit pins break contact which instigates the following functions.

(a) Exhaust air from uncoupling cylinder to allow a spring closure of hinged locking hook ready for next coupling.

(b) Emergency brake set on the set-off car(s).

(c) Reset of all control valves.

5) Electrical box cover is closed by spring pressure when boxes are fully parted.

Concept 301a: WILLISON TYPE II (UIC) COUPLER

Primary Bibliography Reference No.: 301

Related Reference Number(s) 301, 305, 308, 309, 449, 502

Description of Concept
Semi-free, open face, spread claw, fixed knuckle, discontinuous movement;
Gravity type lock (no springs) using five cast unmachined parts;
A preliminary stop in locking mechanism reduces recoil possibility;
Coupler lock, interlocking arms and wedges behind rigid knuckles;
Lateral movement of approximately 0.6" during final coupling;
Lock set can be actuated or released from either side of coupler;
Locking pieces have a rolling action (as compared to the usual sliding action);
Gravity lock is held open at uncoupling, "knuckle" is a solid cast piece;
Visual indication of coupler locked condition, "knuckle open" capability.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Increased gathering Lateral ± 3.95" (2.0 x standard). Vertical ± 2.35" (1.6 x standard).
*IIA2.	- Reduced free slack of 0.28" (0.36 x standard).
*IIA3.	** Positive locking might not be obtained with excess rust or grime build-up since gravity is sole locking force.
*IIB1.	- Should increase coupling speed range.
*IIB2.	- Good vertical interlock and entrapment of broken coupler.
*IIB3.	** Discontinuous lateral coupling movement would tend to create potential for damage to integral air or electrical connectors.
*IIB4.	
IIC1.	
IIC2.	
IIC3.	
*IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	- Allows possibility for an alternate side lever for manual uncoupling.
IIIA2.	- Allows uncoupling in draft (up to approximately 100 lbs. tension).
IIIA3a.	- Accomplishes the "knuckle open" concept.
IIIA3b.	
*IIIA4.	
*IIIB1.	
*IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
* IVB1.	- Improved safety due to reduction of coupler bypass.
* IVB3.	
* IVB4.	
IVB5.	
* IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 301b: SCHARFENBERG KUPPLUNG

Primary Bibliography Reference No.: 301

Related Reference Number(s) 46, 305, 308, 309, 510

Description of Concept

Rigid, flat-faced, matching horn/funnel, symmetrical horizontal disc-shaped "oscillating hooks";
Locking plates are rotated at uncoupling and secured in ready position in a spring loaded recessed catch;
Manual or pneumatic or electro-mechanical uncoupling;
Integral air connection system;
Automatic electric connection at side or top of coupler;
Environmental cover moved aside manually or pneumatically (with electrical contacts also made pneumatically);
Automatic air connection and air valve operation.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	- Air connection integral with rigid coupler head.
*IA2.	- Up to three air lines (including one needed for uncoupling).
*IA3a.	- Air valves are automatically operated by final mechanical operating of coupling.
*IA3b.	** Air connection depends on fixed compression of rubber seals.
IA3c.	
*IB1.	
*IB2.	
*IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Basic gathering range Lateral: ± 7.7" (3.85 x standard). Vertical: ± 5.45" (3.63 x standard).
*IIA2.	** Extended gathering range with use of external horn up to 26.7" lateral - marginal addition due to damage potential of horn with high length/diameter ratio
*IIA3.	- Positive locking from spring loaded locking cam.
IIB1.	- Positive locking, vertical interlock and entrapment from horn/funnel tolerances plus locking cam hooks.
*IIB2.	** Reduced free slack (0.04") from machined faces (complicated system from cost and maintainability viewpoint).
*IIB3.	- Vertical centering from multiple leaf spring.
*IIB4.	** Lateral centering from side hydraulic cylinder may have low reliability due to damage susceptibility.
*IIC1.	
*IIC2.	
IIC3.	
*IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	- Locking plate held in spring loaded ready position (knuckle open condition).
IIIA2.	- Second air system used to transmit pressure to operate uncoupling cylinder (alternate system uses electric solenoids). Good remote uncoupling if a means is available to select cars for uncoupling.
*IIIA3a.	** Uncoupling subject to marginal reliability after use and environmental grime contamination due to high force required to rotate both locking plates (against coupling draft force friction) and to compress both recoupling springs.
IIIA3b.	
IIIA4.	
*IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Electrical contacts are held away from environment.
IVA2.	** Manual cover removal system subject to damage possibility.
* IVB1.	- Combination of pneumatic removal of cover and pneumatic engagement of contacts (after coupling forces are complete) has good reliability potential.
* IVB3.	- Improved reliability.
* IVB4.	
IVB5.	
* IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 306: FREIGHT MASTER POSITIONING DEVICE

Primary Bibliography Reference No.: 306

Related Reference Number(s) 515

Description of Concept

Direct linkage from trucks through rod and chain with spring slack take-up.

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	- Simple device which should be economical in cost and maintenance (assuming adequate design stresses).
IIB4.	
IIC1.	** User reports of maintainability after extended usage.
IIC2.	
*IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	- Improved safety by reducing bypass probability.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 309: UNICUPLER (U.I.G.) COUPLER

Primary Bibliography Reference No.: 309

Related Reference Number(s) 33, 47, 49, 301, 308, 309, 502

Description of Concept

Semi-rigid, open face, spread claw, internal hinged hook (ridigized Willison with hinged hook);

Uses ORE II - cross beam centering device Biblio. No. 318);

Hinged environmental cover is wedged opened at coupling;

Round electrical connector with pin/socket mating.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: *IA1. *IA2. IA3a. IA3b. IA3c. *IB1. *IB2. *IB3.

- Air connection integral with non-compatible rigid coupler head.
- Final sealing pressure is attained by forward movement of connectors from cam actuated by coupler closure.
- Air lines can be opened from rear of connected coupler for maintenance (pivoted opening).
- Air connectors are well protected by recess in coupler head.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: *IIA1. *IIA2. *IIA3. *IIB1. *IIB2. *IIB3. *IIB4. *IIC1. *IIC2. IIC3. *IID.

- Basic gathering range.
  Lateral: ± 8.7" (4.35 x standard).
  Vertical: ∓ 5.5" (3.67 x standard).
- Simple, internal, spring loaded hinged hook for locking, interlock and entrapment.
- Most simple of hinged-hook Willison types.
- Basic cast/forged head and shank is extremely rugged with minimum of machining to obtain 0.31" free slack.
- Locking mechanism composed of approximately six unmachined steel castings plus one spring.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: *IIIA1. IIIA2. *IIIA3a. IIIA3b. IIIA4. *IIIB1. *IIIB2.

- Alternate (2nd side) uncoupling lever using a cable connection or rigid joint and shaft.
- Alternate uncoupling release by air valve located at side of car.
- Locking pawls (knuckles) are spring loaded in ready position at uncoupling.
- Locking pawls can be manually locked open to prevent automatic recoupling during switching operations.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1. IVA2. * IVB1. * IVB3. * IVB4. IVB5. IVB6. * IVC.

- Electrical connections integral to coupler.
- Electrical pin/socket connections are clustered around an air connector (protected area).
- Final electrical contact made by air pressure after coupling closure.

** Environmental protection covers are manually cammed aside at coupling (damage susceptible).

- Electrical contacts can be opened (hinged aside) from rear of coupled unit.

** Round connector limits number of circuits.

** Rigid pin/socket type contacts subject to damage and malfunction due to free slack (0.31") movements of coupler.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 318: ORE II CROSS-BEAM SUPPORT CENTERING DEVICE

Primary Bibliography Reference No.: 318

Related Reference Number(s) 459

Description of Concept

Cross beam support.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	- Spring actuated centering device ($\pm$ 1.2" from centerline of car).
IIA2.	- Simple rugged, reliable.
IIA3.	- Manual disengagement and automatic reengagement.
IIB1.	- Nominal initial cost and minimal maintenance.
IIB2.	
IIB3.	
IIB4.	
*IIC1.	
IIC2.	
IIC3.	
*IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 387: GERMAN UIC ELECTRICAL CONTROL

Primary Bibliography Reference No.: 387

Related Reference Number(s)

Description of Concept

Electrical control signaling using multiplexing principal (simultaneous transmission of multiple signals on one line).

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions

- IA1.
- IA2.
- IA3a.
- IA3b.
- IA3c.
- IB1.
- IB2.
- IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions

- IIA1.
- IIA2.
- IIA3.
- IIB1.
- IIB2.
- IIB3.
- IIB4.
- IIC1.
- IIC2.
- IIC3.
- IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions

- IIIA1.
- IIIA2.
- IIIA3a.
- IIIA3b.
- IIIA4.
- IIIB1.
- IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Train sensing and brake control system.
* IVA2.	** Requires electrical connection system and electronic control package in each car and locomotive.
IVB1.	
IVB3.	
IVB4.	
IVB5.	
* IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 391: OSAKA COUPLER SYSTEM

Primary Bibliography Reference No.: 391

Related Reference Number(s)

Description of Concept

Hinged locking hook (spring-loaded) automatically engage opposite horn at coupling;
Provisions for mounting a lower suspended electrical connector system;
Automatic air connection, "knuckle" always open and remote (air actuated) uncoupling.
Butt type seals;
Rigid type, flat face, horn-funnel;
Rotary locking block can be opened by operation of air cylinder or manual.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	- Two air lines automatically connected at coupling.
*IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Improved gathering range. Lateral = ± 3.9" (1.95 x standard). Vertical = ∓ 3.9" (2.6 x standard).
*IIA2.	- Positive locking from spring loaded hinged hook and rotary block locking.
*IIA3.	- Machined rigid face = "no" free slack.
IIB1.	- Vertical interlock and entrapment from horn-funnel interlock plus rotary block lock.
*IIB2.	- Simple construction and slack free design should reduce maintenance.
*IIB3.	
*IIB4.	
IIC1.	
*IIC2.	
IIC3.	
*IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	- Offers remote uncoupling from within train.
IIIA2.	- Capability of uncoupling and draft (28 psi line pressure needed for up to 2,000 lb. draft force and 100 psi at 8,800 lbs. draft force).
*IIIA3a.	- "Knuckle" always open at uncoupling.
IIIA3b.	
*IIIA4.	
*IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Offers easy potential for automatic electrical system.
IVA2.	- Improved safety due to automatic air connection and reduced probability of coupler by-pass.
* IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 428a: STANDARD AAR "H" TIGHTLOCK

Primary Bibliography Reference No.: 428

Related Reference Number(s) 446

Description of Concept

Passenger car application;
Optional double lock-lift assembly;
Interlocking feature;
Reduced free slack.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Increased lateral gathering: $\pm$ 2-3/8" (1.19 x standard).
*IIA2.	- Increased vertical gathering: 4-1/2" total (1.5 x standard).
IIA3.	- Reduced free slack: 0.25" (0.32 x standard).
*IIB1.	- More positive coupler engagement at low speeds.
*IIB2.	** Tight machined tolerances on all mating surfaces causes a significant increase in original cost.
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
*IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
*IIIA1.	
IIIA2.	
IIIA3a.	- Allows use of two side uncoupling levers.
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	- Same basic features as type "F" coupler (ref. No. 428b) except in a higher grade steel with greater machining to reduce free slack.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 428b: STANDARD AAR "F" INTERLOCKING COUPLER

Primary Bibliography Reference No.: 428

Related Reference Number(s) 9, 38, 52, 405, 502 (N.C.), 553

Description of Concept

Tank car, long car, or dangerous car application

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	- Increased lateral gathering: ± 2-3/8" (1.19 x standard).
* IIA2.	- Increased vertical gathering: 4-1/2" total (1.5 x standard).
IIA3.	- Reduced tree slack; 3/8" (0.48 x standard).
IIB1.	- Six way interlock and entrapment (when mated with another "F").* When mated with "E" will allow "E" to ride over top.
* IIB2.	** Requires vertical spring carrier due to coupler head interlock.
* IIB3.	** Problem of knocking ears off in misaligned couplings.
* IIB4.	** Excess failures at shank pin hole.
IIC1.	
* IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	- Interlocking feature helps reduce derail probability under the condition of broken coupler head or shank.
IVB3.	
IVB4.	** Protects other car but not always "F" car from override damage.
IVB5.	
IVB6.	** Sharp edges of interlocking ears may promote puncture in derailments.
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 434a: COBB AIR CONNECTOR SYSTEM

Primary Bibliography Reference No.: 434

Related Reference Number(s)

Description of Concept

Car mounted, twin unit, horn-funnel type with angled line connections (spring loaded); Automatic air connection.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	- Add-on unit (compatible with built-in gathering).
* IA2.	** Angled air connections subject to coupling damage.
IA3a.	** Long cantilever design subject to potential vibration problems and shock damage to mounting.
IA3b.	** Sliding spring tubes subject to binding.
IA3c.	** Connector units do not swing with coupler and subject to by-pass due to limited gathering.
* IB1.	
* IB2.	
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Improved safety due to automatic air connection.
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 434b: FRANCIS AIR CONNECTOR SYSTEM

Primary Bibliography Reference No.: 434

Related Reference Number(s)

Description of Concept

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

Automatic air connection;

Car mounted (with coupler guide), cone-ring type with butt line connections (spring loaded).

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	- Add-on unit (compatible with built-in gathering.
* IA2.	** Air seal subject to permanent damage from point of opposite gathering cone.
IA3a.	** Recesses in front face allow solid stop before seating.
IA3b.	** Wide seating face requires critical alignment toachieve proper sealing before solid stop.
IA3c.	
* IB1.	
* IB2.	
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	- Improved safety due to automatic air connection.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 448a: OHIO BRASS FORM 8 COUPLER

Primary Bibliography Reference No.: 448

Related Reference Number(s) 503

Description of Concept

Rigid, non-reversible, male/female coupler (mine car application); spring actuated locking cam in female coupler is always ready.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	
*IIA2.	* Concept not adaptable to general railroad operations due to the requirement for specific car orientation to achieve coupling.
*IIA3.	
IIB1.	
*IIB2.	
IIB3.	
IIB4.	
*IIC1.	
*IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
*IIIA1.	- "Open knuckle" capability.
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 448b: OHIO BRASS FORM 9 COUPLER

Primary Bibliography Reference No.: 448

Related Reference Number(s) 503

Description of Concept

Rigid, non-reversible, male/female coupler with integral air connector;

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: *IA1., IA2., IA3a., IA3b., IA3c., IB1., IB2., IB3.

- Same non-compatible system as O.B. form 8 (biblio. 448) except:
- Air connection integral with non-compatible rigid coupler head;
- Spring loaded air seal should be reliable to retain seal within coupler movements.
- Rotary air union for rotating dumper.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., IIC1., IIC2., IIC3., IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., IVC.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 449: ALTERNATOR-BATTERY SYSTEM FOR SUPPLYING POWER

Primary Bibliography Reference No.: 449

Related Reference Number(s) 503

Description of Concept

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

Alternator-battery electrical power system (power source within each car).

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
* IVB1.	A viable alternate concept for supplying power for control functions in each car without requiring inter-car power connections.
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 450a: OHIO BRASS FORM 8A COUPLER

Primary Bibliography Reference No.: 450

Related Reference Number(s)

Description of Concept

- Same capabilities as O.B. form 8 (Biblio. No. 448) plus:

Automatic electric braking;

Automatic electric connector system with spring loaded rotating contact mating mercury relay contact switching;

Electrical logic and control system;

Automatic remote coupling and uncoupling;

Automatic uncoupling release through electric solenoid (liner actuator).

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	X
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: IA1., IA2., IA3a., IA3b., IA3c., IB1., IB2., IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., IIC1., IIC2., IIC3., IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., * IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

- Potential application for systems with electric power and control circuits.

** Electric solenoid must be environmentally protected to preclude rust of plunger or core.

** Electric solenoid must have overload protection to preclude burnout if unable to complete uncoupling movement.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., * IVA2., * IVB1., * IVB3., * IVB4., * IVB5., * IVB6., * IVC.

** Electrical brakes are not practical for freight cars due to the extreme braking energy required.

- Rotating spring electrical contact system should be reliable and resistant to contact problems from grime, etc.

** Mercury contacts may be subject to extraneous malfunction from vibration and shock.

- Logic system is electronically sound and requires a minimum of circuits for adequate control.

- Remote coupling and uncoupling improves safety.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 450b: MICROWAVE TRANSMISSION CONTROL SYSTEM

Primary Bibliography Reference No.: 450

Related Reference Number(s) 503

Description of Concept

Automatic uncoupling release from either internal or external microwave signal.

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	- Viable alternate concept for control and sensing transmission (not power) without inter-car control electrical connections.
IIIA3a.	
*IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 451a: NATIONAL AIR CONNECTOR

Primary Bibliography Reference No.: 451

Related Reference Number(s) 434

Description of Concept

- Coupler mounted, ball-funnel type with angled line connections (spring loaded);
- Automatic air connection.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	X
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	** Built-in gathering angle air connections subject to coupling damage.
* IA2.	- Weight of approximately 166 lbs.
IA3a.	
IA3b.	
IA3c.	
* IB1.	
* IB2.	
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	- Improved safety due to automatic air connection.
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 451b: ROBINSON AIR CONNECTOR

Primary Bibliography Reference No.: 451

Related Reference Number(s) 434

Description of Concept

Pin-funnel type automatic air connection;

Butt line connections (spring loaded).

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	Built-in gathering
* IA2.	- Weight of approximately 129 lbs.
IA3a.	** Tendency to bind before sealing due to scraping and wear scoring near bottom of funnel (corrected with change to ball type gathering horn).
IA3b.	
IA3c.	
* IB1.	** Some interference between air lines and mounting brackets.
* IB2.	** Some wear from coupling-uncoupling cycling.
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	- Improved safety due to automatic air connection.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 451c: ROBERTS AIR CONNECTOR

Primary Bibliography Reference No.: 451

Related Reference Number(s) 434

Description of Concept

Coupler mounted, spread-wing type with butt line connections (spring loaded);

Automatic air connection.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	Built-in gathering
*IA2.	** Excessive weight of approximately 227 lbs.
IA3a.	** Unstable spread-wing design (high engagement angle) results in binding and twisting of wings.
IA3b.	** Unacceptable high wear rate from cycling.
IA3c.	** Tendency to bind and seize with wear.
*IB1.	
*IB2.	
*IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions
IIA1.
IIA2.
IIA3.
IIB1.
IIB2.
IIB3.
IIB4.
IIC1.
IIC2.
IIC3.
IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions
IIIA1.
IIIA2.
IIIA3a.
IIIA3b.
IIIA4.
IIIB1.
IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	- Improved safety due to automatic air connection.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 451d: JOHNSON AIR CONNECTOR

Primary Bibliography Reference No.: 451

Related Reference Number(s) 434

Description of Concept

Car mounted (with coupler guide), scoop-knob type with angled line connections (spring loaded);

Automatic air connection.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	Built-in gathering
* IA2.	** Excessively heavy (approximately 440 lbs.) and complicated (80 parts)
IA3a.	** Angled air connections subject to coupling damage.
IA3b.	** Steel buffer spring tubes subject to binding.
IA3c.	** Long cantilever effect caused excess vibration damage when uncoupled.
* IB1.	
* IB2.	
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	Improved safety due to automatic air connection.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 451e: "COMPATIMATIC" AIR CONNECTOR

Primary Bibliography Reference No.: 451

Related Reference Number(s) 434, 451e, 511b

Description of Concept

- Same unit as WABCO train air connector described in Biblio. No. 511b.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	- Ref. Biblio. No. 511b - WABCO train air connector.
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 451f: AMERICAN AIR CONNECTOR

Primary Bibliography Reference No.: 451

Related Reference Number(s) 434

Description of Concept

Compatibility with AAR Type "E" Coupler:		
1. Can be added to Type "E"	X	Coupler mounted, horn-funnel type with angled line connections (spring loaded); automatic air connection.
2. Requires modification of Type "E"		
3. Requires head adapter for Type "E"		
4. Incompatible with Type "E"		

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	
* IA2.	
IA3a.	* Built-in gathering angle air connections subject to coupling damage
IA3b.	* Tendency to score and scrape at sharp corners of gathering horn and funnel.
IA3c.	- Weight of approximately 182 lbs.
* IB1.	
* IB2.	
* IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	- Improved safety due to automatic air connection.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 452: DRESSER ESACS CONTROL SYSTEM

Primary Bibliography Reference No.: 452

Related Reference Number(s) 448, 517, 1042

Description of Concept

Multiplexing sensory and control system.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Train sensing and control using a minimum (approximately 5) electrical interconnection lines.
* IVA2.	** Requires electrical connection system and "black box" electronic logic package in each car in order to function.
IVB1.	
IVB3.	
IVB4.	
* IVB5.	
* IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 457: DOWTY AUTOMATIC CENTRAL COUPLER

Primary Bibliography Reference No.: 457

Related Reference Number(s)

Description of Concept

Semi-rigid, discontinuous movement, "V" shaped gathering horns (on 45° slant), spring loaded latch and lock;
Uncoupling lever rotates out lock and pushes the mating latch out of lock position;
Latches and locks are spring loaded in ready position;
Uncoupling lever can be locked in open position (requires manual disengage);
"Knuckle" always open and automatic air connection.
Automatic air connector-supported below semi-rigid coupler head with automatic connection and improved performance.

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	** Rigid support of air connector depends on coupler for gathering and holding.
IA2.	
IA3a.	** Butt type rubber seal with closure force maintained by a backing of compressed rubber blocks (possibly subject to less of sealing force due to aging of rubber).
IA3b.	
IA3c.	
*IB1.	
*IB2.	
*IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Large gathering range Lateral = ± 7" (3.5 times standard gathering range). Vertical = ± 7" (4.7 times standard gathering range).
*IIA2.	- Hinged locks and latches slide together and interlock.
*IIA3.	** Discontinuous coupling movement at 90° force angles may create excessive shear forces on hinge pins.
*IIB1.	
IIB2.	- Coupling possible up to 15 mph (3.75 times standard maximum speed).
*IIB3.	- Vertical interlock and entrapment achieved by wedging action of 45° offset (90° total) "V" shaped gathering horns plus locks and latches.
*IIB4.	
*IIC1.	** Coupler shank supported by spring attached to a spherical rubber joint for centering - possibly subject to malfunction from rubber fatigue from draft movements and continuous vibration under stress of coupler weight.
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	- Achieves positive uncoupling release in draft
IIIA2.	
IIIA3a.	- Locking latches (knuckle) are spring loaded in open position at uncoupling.
IIIA3b.	
*IIIA4.	
*IIIB1.	- Allows yard switching where coupling will not automatically take place.
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	- Improved safety due to automatic air connection and reduced by-pass probability.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 458: ROBINSON AIR CONNECTOR

Primary Bibliography Reference No.: 458

Related Reference Number(s) 434, 451

Description of Concept

Automatic air connection;

Coupler mounted, spread-wing type with butt line connections (spring loaded compressible rubber seals).

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: * IA1., * IA2., IA3a., IA3b., IA3c., * IB1., * IB2., * IB3.

Built-in gathering

- ** Tendency to bind and seize with wear.
- \- Detachable air passage and seal system allows use of a cheaper base casting.
- ** High wear rate from cycling (can apparently be reduced or alleviated by wing design changes to higher strength and rigidity).
- \- Spread-wing design includes a potential for later design changes for greater gathering range while retaining interchangeability.
- \- Individual spring loaded rubber seals should enhance cold weather sealing.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., IIC1., IIC2., IIC3., IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., * IVC.

- Improved safety due to automatic air connection.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 501: ASF COUPLER KNUCKLE CONTOUR CHANGE

Primary Bibliography Reference No.: 501

Related Reference Number(s)

Description of Concept

Revise front shape of knuckle and add 5/64 in. to front of knuckle;

Reduced free slack and greater lateral gathering range.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Increased lateral gathering: 6-7/8" total (1.7 x standard).
IIA2.	- Decreased free slack: 5/8" total for two mated "E" couplers so modified (0.8 x standard).
IIA3.	
IIB1.	
*IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	- Improved safety due to reduced bypass probability.
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 502a: NATIONAL CASTINGS I.G.R. COUPLER KNUCKLE

Primary Bibliography Reference No.: 502

Related Reference Number(s)

Description of Concept

Revise front shape of knuckle;
Increased lateral gathering range.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Increased lateral gathering: 5/7/8" total (1.47 x standard).
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	- Improved safety due to reduced bypass probability.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 502b: NATIONAL CASTINGS "COMPATIMATIC" COUPLER

Primary Bibliography Reference No.: 502

Related Reference Number(s)

Description of Concept

Compatibility with AAR Type "E" Coupler:		
1. Can be added to Type "E"	X	Knuckle is always open;
2. Requires modification of Type "E"	X	Rotary bottom lockset is alternate;
3. Requires head adapter for Type "E"		Knuckle is automatically spring loaded in open position at uncoupling;
4. Incompatible with Type "E"		

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	- Assured maximum lateral gathering range of: "E" system: 4" total (1.0 x standard). "F" system: 4-3/4" total (1.19 x standard).
IIA2.	
* IIA3.	- Positive locking at coupling by the compatimatic device rotating the lockset and allowing lock to drop in place.
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
* IIIA1.	- Allows use of alternate side uncoupling lever.
IIIA2.	- Knuckle always open and connot vibrate or shock closed without coupling action.
IIIA3a.	
IIIA3b.	
IIIA4.	
* IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	- Improved safety due to decreased probability of bypass.
IVB3.	
IVB4.	
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 502c: NATIONAL CASTINGS AIR/ELECTRICAL CONNECTOR

Primary Bibliography Reference No.: 502

Related Reference Number(s)

Description of Concept

Coupler mounted, modified spread-wing type with butt line seal (spring loaded);
Modified spread-wing design depends on coupler for primary gathering (three gathering lugs with approximately 3/4" depth);
Mounting elexibility is limited to longitudional spring travel;
Spring loaded compression of rubber butt type seal;
Backing spring provides closure force for both air/electrical connections;
Gathering range and vertical movement range is limited;
Electrical control of air valves;
Automatic air connection and remote uncoupling;
Uncoupling release from within train by operation of the uncoupling lever from an electric solenoid operated through train electric line.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: *IA1., *IA2., *IA3a., *IA3b., IA3c., *IB1., *IB2., *IB3.

- Designed for use with an "F" type interlocking coupler.
- Desirable weight of approximately 60 lbs.

** Limited for use with gathering provided by "F" coupler and interlocking protection.

** No provision for "mixed" coupling connection.

- Good basic sealing design.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., IIC1., IIC2., IIC3., IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., *IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

** Electric solenoid could require an ecxessive power load to "break loose" uncoupling rods in a bind or rusty or frozen in place.

** System only good for the one car immediately behind locomotive.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., * IVB1., IVB3., IVB4., IVB5., * IVB6., * IVC.

- Compatible with "F" system (add-on unit).

** Primary connector spring design must be strong enough to maintain forward force required for both air/electrical connections.

- Each electrical contact has a separate loading spring.

** Designed for use with an "F" type interlocking coupler system.

** Valve control limited to first car behind locomotive.

- Improve safety due to automatic air connector.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 502d: WILLISON MINE CAR COUPLER

Primary Bibliography Reference No.: 502

Related Reference Number(s) 448

Description of Concept

Same design concepts as Willison Type II; Biblio. No. 301a except on a smaller scale;

Rubber cushioning units on both sides of shank to achieve self centering.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions

IA1.
IA2.
IA3a.
IA3b.
IA3c.
IB1.
IB2.
IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions

IIA1.
IIA2.
IIA3.
IIB1.
IIB2.
IIB3.
IIB4.
*IIC1.
IIC2.
IIC3.
IID.

** Potential for loss of restraining and centering capabilities due to loss of resiliency of rubber due to environmental and temperature aging.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions

IIIA1.
IIIA2.
IIIA3a.
IIIA3b.
IIIA4.
IIIB1.
IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions

IVA1.
IVA2.
IVB1.
IVB3.
IVB4.
IVB5.
IVB6.
IVC.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 503: OHIO BRASS RAPID TRANSIT COUPLER

Primary Bibliography Reference No.: 503

Related Reference Number(s) 254, 448

Description of Concept

Form 15
Form 21 Are all similar to bibliography reference 503a.
Form 26

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 503a: OHIO BRASS FORM 70 (SOAC RAPID TRANSIT) COUPLER

Primary Bibliography Reference No.: 503

Related Reference Number(s)

Description of Concept

Rigid, flat face, automatic, tightlock, horn-pocket type; 4" symetrical horn fits opposite recessed pocket; mechanical interlocking of spring-loaded hinges hooks; flat machined coupler faces; interlocking hocks and aligning pins/dowels; side air cylinders working against shank; tightlock coupler with mating flat faces; lubrication fittings in coupler head and at drawbar joints and replaceable nylon and manganese steel wear plates; rigid coupler with integral automatic air connections and automatic operation of air valves improved performance; uncoupling by electrical signal to air cylinder; air cylinder forces cam to wedge open locking hook (no actuate opposite cam); spring loaded hook always ready to couple; Walton electro-pneumatic system with: automatic electrical system actuated by completion of mechanical coupling through time delay solenoid contact closure; environmental cover automatically operated by coupling forces; uncoupling and slack free design; electrical control of air valves and uncoupling; automatic air connection, valve control.

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: *IA1., *IA2., IA3a., *IA3b., *IA3c., *IB1., *IB2., *IB3.

- Two spring loaded air connections with compressed rubber gaskets provide good sealing.
- Air valve control from Walton electric pneumatic switching system.
- Less air leakage, reduced maintenance.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: *IIA1., *IIA2., *IIA3., IIB1., *IIB2., *IIB3., *IIB4., *IIC1., *IIC2., IIC3., *IID.

- State of the art (SOAC) rapid transit coupler.
- ** Design is proven in rapid transit applications, but size, gathering range and strength is limited.
- Not compatible with "E" system.
- Lateral ± 3-3/8" (1.7 times standard), vertical ± 3" (2.0 times standard).
- Positive locking at coupling.
- Free slack 0.14" (0.18 times standard).
- Good vertical interlock and broken coupler entrapment.
- Positive self centering with automatic disengagement at a coupling.
- Minimum of contour angling - requires vertical articulation.
- Good concepts for reducing long range maintenance and replacement costs.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., *IIIA3a., IIIA3b., *IIIA4., *IIIB1., IIIB2.

- Automatic uncoupling release from within train.
- Gives a limited capability for uncoupling in draft (estimate up to 1,000 lb. draft force).
- Equivalent to automatically opened knuckle.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: * IVA1., IVA2., * IVB1., * IVB3., * IVB4., IVB5., * IVB6., * IVC.

- Electric connection system is adaptable to rigid couplers.
- Automatic brake control and electric contact system same as Walton control system (Ref. No. 254).
- Acceptable electrical contact unless excess contact contamination.
- Up to 59 circuits at 30A - 32V capacity.
- Protection from environment for electrical contacts.
- ** Cover has probability for maintenance problems from coupling damage.
- Positive hands off control.
- Improved safety.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 503b: OHIO BRASS FORM 29 (RAPID TRANSIT) COUPLER SYSTEM

Primary Bibliography Reference No.: 503

Related Reference Number(s)

Description of Concept

"C-O-B" coupler centering device using side spring carriers;

"C-O-B" drum switch for completing electrical connections.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E" electrical	only X
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: IA1., IA2., IA3a., IA3b., IA3c., IB1., IB2., IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., *IIC1., IIC2., IIC3., IID.

- Same basic system as O.B. form 70 (biblio. No. 503a) in smaller size plus:
- Positive spring self-centering (for uncoupled car) which is automatically released upon coupling by an air operated switch.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., * IVB1., * IVB3., IVB4., IVB5., IVB6., IVC.

- Compatible with "E" system only as part of a new control system.
- Rotating sliding-finger contacts have demonstrated a long life and high reliability and should not be subject to extraneous action from environmental forces assuming adequate protection from freezing water on the contacts.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 503c: OHIO BRASS FORM 73 (RAPID TRANSIT) COUPLER

Primary Bibliography Reference No.: 503

Related Reference Number(s)

Description of Concept

Increased vertical gathering range from an external horn extending out and diagonally down from the front face of the coupler.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
*IIA2.	- Same basic system as O.B. Form 70 (Biblio. No. 503a) plus:
IIA3.	** Extended gathering range is of doubtful reliability due to the damage susceptibility from high moment ratio of the horn length/diameter.
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 503d: OHIO BRASS FORM 5 (RAIL PASSENGER) COUPLER

Primary Bibliography Reference No.: 503

Related Reference Number(s)

Description of Concept

Semi-free, modified knuckle type with side pin/pocket interlock;
Pin/pocket interlock at sides of coupler;
Semi-machined interlock surface faces;
Pin/pocket interlock with horizontally hinged shank and head supported by spring;
Optional electric connector suspended below coupler head;
Reduced free slack and semi-locked coupler heads.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	- Positive locking to prevent vertical and lateral movement (if knuckle remains closed).
IIA2.	
* IIA3.	- Basic reduction of free slack from machined faces.
IIB1.	
* IIB2.	- Semi-locked coupler heads reduce contour angling but require vertical articulation and head support.
* IIB3.	
IIB4.	
IIC1.	
* IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Electric connector compatible only as part of a new control system.
IVA2.	
* IVB1.	** Greater probability for road damage and environmental contamination than for side mounted electric connector.
IVB3.	
IVB4.	- Improved safety due to reduced bypass probability.
IVB5.	
IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 511a: WABCO N-2 MASS TRANSIT COUPLER SYSTEM

Primary Bibliography Reference No.: 511

Related Reference Number(s) 551, 552, 612

Description of Concept

With integral air connection using compressed rubber butt seals;
System (rigid, flat face, dish and guide pin type with integral air and electrical connectors);
Uncoupling initiates by pneumatic signal;
Manual uncoupling requires unbolting of pin and coupler;
Lower attached electrical connector;
Environmental cover rotated down (by depression of a long guide pin) through coupling contact of mating coupler;
Electrical contacts are engaged (with spring force) when coupler faces are 0.62" apart as part of final coupling;
Reduced slack and automatic air connection.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: * IA1., IA2., * IA3a., * IA3b., * IA3c., * IB1., * IB2., * IB3.

** Locking of coupler provides force for compression of butt rubber-to-rubber seals (potential for leakage as rubber ages or locking latch wears).
- Pin/dish coupler is aligned to ± 0.012" when coupler faces are 5" apart, thus no shear forces on rubber seals.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: * IIA1., * IIA2., * IIA3., IIB1., * IIB2., * IIB3., * IIB4., * IIC1., IIC2., IIC3., IID.

- Increased gathering range
  Lateral: ± 4" (2.0 x standard).
  Verticle: ± 4" (2.7 x standard).
- Positive locking, interlock and entrapment through mating dish and guide pins and spring loaded locking latches snapped into prong slots in pins.
- "Zero" slack (from machined faces and locking latches).
** Centering from tension spring and chain links attached on either side of coupler head may be subject to malfunction from kinking of chain.
** Horizontal "coupler compensator" support springs reported to deteriorate with age and use.
** Increased slack (and resulting poor air and electrical contacts reported from elongation of secondary guide pins with usage.
** "Freezing" of draft gear reported due to lack of lubrication (no fittings provided)

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., * IIIA2., * IIIA3a., IIIA3b., IIIA4., * IIIB1., IIIB2.

- Allows remote uncoupling release from side of car or within cab of car being uncoupled.
** Not a feasible system for manual uncoupling.
** Problems reported wherein uncoupling could not be accomplished by standard pneumatic system due to the coupler guide pin hanging up in the dish locking system (reportedly caused by coupling at "improper" angle).

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., * IVB1., * IVB3., * IVB4., * IVB5., * IVB6., * IVC.

- Electrical connector system could be compatible with "E" system as part of an add-on control system.
** Potential for malfunction of environmental cover from damage to door depressing pin caused by coupling forces in wide angle coupling.
** Potential for damage to contact insulators from misaligned couplings due to the close interlocking tolerances and depth which the plastic insulators must engage.
- Improved safety.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 511b: WABCO TRAIN AIR LINE CONNECTOR

Primary Bibliography Reference No.: 511

Related Reference Number(s)

Description of Concept

Coupler mounted, "spread-wing" type with integral gathering capacity, angled line seals using rubber ball compression force;

Automatic air connection.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: *IA1., IA2., IA3a., IA3b., IA3c., IB1., IB2., IB3.

- Desirable weight of approximately 52 lbs.
- Uses basic gathering and centering of mechanical coupler plus integral 5" lateral and 4" vertical gathering.
- Has flexible mounting system to compensate for vertical movements of "E" coupler system.

** Environmental susceptibility and wear resistance cannot be identified until system is field tested.

** Potential maintenance problem with angled seals.

** Rubber ball compression to establish sealing force may be subject to aging deterioration.

- "Mixed" coupling made by swiveling connector 80° and connecting glad hand at rear.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., IIC1., IIC2., IIC3., IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., * IVC.

- Improved safety due to automatic air connection.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 511c: WABCO TRAIN LINE ELECTRICAL CONNECTOR

Primary Bibliography Reference No.: 511

Related Reference Number(s)

Description of Concept

Attached as part of air connector system - held in contact by compression of "rubber ball" pressure in air connector;

Environmental cover "levered" out of way by coupling action of air connectors.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	** Reliability of electrical contacts is questioned on the basis of uniformity and consistency of contact pressure maintained by "rubber ball" compression.
IVA2.	
* IVB1.	
* IVB3.	** Susceptibility of door to damage is questioned for wide angle coupling wherein one side approaches contact much earlier in the coupling sequence.
* IVB4.	
* IVB5.	
* IVB6.	
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 516a: WALTON AUTOMATIC COUPLER

Primary Bibliography Reference No.: 516

Related Reference Number(s) 700

Description of Concept

Automatic air connections within head of rigid coupler (using replaceable rubber compression rubber butt seals);
Rigid, flat faced, matching horn-funnel, hinged hook type with integral air and electrical connectors and automatic self centering;
Spring loaded locking horns are automatically "open" for coupling;
Automatic air connection and "knuckle" always open.

Note: A description of the control system is included in Biblio. No. 254.

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: * IA1., * IA2., IA3a., IA3b., IA3c., * IB1., * IB2., * IB3.

- Seals are readily replaceable (in free or coupled state) by removing the screw-in air pipe connection.

** Gaskets are subject to possible leakage after wear and aging since the seal depends solely on compression of rubber by the coupler lock. No back up device (such as spring loading) is used to take up coupler slack.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: * IIA1., * IIA2., * IIA3., IIB1., * IIB2., * IIB3., * IIB4., * IIC1., IIC2., IIC3., IID.

- Similar to S-W 800 system (Biblio. No. 9) in concept except:
  - Free slack: 0.05" (0.06 times standard).

** No positive coupler lock per se; a cam type "keeper" arrangement is used to retain the coupled condition in the event of a broken spring holding the hinged hook.

- Self centering accomplished by horizontal air cylinder acting on the shank.
- Increased gathering range.
  Lateral: $\pm$ 3-1/2" (1.75 x standard).
  Vertical $\pm$ 3-1/2" (2.33 x standard).

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., * IIIB1., IIIB2.

- Effective as "knuckle" automatically open.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., * IVC.

- Improved safety due to automatic air connection.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 516b: WALTON ELECTRICAL CONTROL BOX SYSTEMS

Primary Bibliography Reference No.: 516

Related Reference Number(s) 630, 700

Description of Concept

See pages following

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions
IA1.
IA2.
IA3a.
IA3b.
IA3c.
IB1.
IB2.
IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions
IIA1.
IIA2.
IIA3.
IIB1.
IIB2.
IIB3.
IIB4.
IIC1.
IIC2.
IIC3.
IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions
IIIA1.
IIIA2.
IIIA3a.
IIIA3b.
IIIA4.
IIIB1.
IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions
IVA1.
IVA2.
* IVB1.
* IVB3.
* IVB4.
IVB5.
IVB6.
IVC.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

WALTON ELECTRICAL CONTROL BOX SYSTEMS (CONT'D.)

General Description of Concept	Evaluation of Concept Significance
Walton Electric Control Box Systems: Various systems used in rapid transit applications use the following concepts: Fixed extended pilot pins and regular system pins are individually spring loaded and make direct butt contact on flat front faces; All contacts are silver plated over a brass type conductor; Internal wiring is direct bolt/nut to rear of contact pins Fixed extended pilot pins make baisc contact to energize the control system (at first coupling). Control system supplies air to piston and rubber diaphragm (in electric box) to extend the contact block (with the remaining system pins) into the forward engaged position. To disengage, the control system releases air from the piston and a spring system retracts the contact block.	** A basic design problem to be faced is that of the ability of the coupler gathering systems to absorb the impact and misalignment energies so the electrical box experiences only direct in-line movements and minimal impact forces. - Individual spring loading is needed to compensate for variations in contact block flatness. ** Some amount or contact rotation would seem desirable to make the best electrical connection. ** For long-range maintenance, replaceable silver contact tips would be desirable. - Good system continuity would require all supporting contacts to be bolt/nut or compression threaded type. ** Since good electrical contact of the pilot pins is essential for the control system to operate, these circuits should be redundant.

Manual extension/retraction is possible by use of a self-contained hand crank.

(1) Side mounted (with swing type cover).

- Cover is attached to extended radius spring loaded mounting arms and has cam shaped front with a guide arm facing forward and outward.
- As the couplers come together, the contact of the opposing cam shaped covers results in a wedging action which forces the opposing covers to swing to the outside, exposing the electrical contacts.

(2) Lower mounted (with track type cover).

- The cover rides in a recessed track running beneath the electric box and is spring loaded in the closed position.
- A horizontal push bar is compressed approximately 1-1/2 inches by a similar unit on the opposing

** The use of a rubber diaphragm may present some problems with leakage from cracks brought on by age embrittlement.

- Since the entire piston/diaphragm system is enclosed in the electrical box, environmental grime problems should be negligible.
- Should be reliable for efficient contact disengagement.
- Good back-up in case of a system malfunction.

** The guide arm should be of massive design since it must take the initial impact and stress before the cover starts to move.

** The covers are required to lever each other aside while in full contact. This would seem to place undue stress on the mounting points due to the sliding friction between covers. It would seem that easier opening would be achieved by having total opening forces applied coupler. The rearward movement of this bar is transmitted through a rack and pinion gear to pull the cover down and under the box (following the recessed track).

(3) No cover.

- A rubber gasket is fitted around the contact block to provide a tight seal between opposing electrical boxes when coupled.

(4) Plastic covers are applied to the facing surfaces of the metal covers to protect the fixed extended pins from accidental short circuit in the event of a bent or damaged cover assembly.

to the guide arm which would have a better lateral force moment.

** The recessed track would have a high probability of clogging up with grime or ice, thus blocking the path needed for cover movement.

**The push bar runs the full width of the electric box (and coupler). There is a high probability of an impact on one edge during any wide angle coupling. The bar (and its sliding push rod mechanism) would have to be extremely strong to withstand the resulting lateral forces while still compressing equally on both sides as needed for proper opening of the door.

- The use of a sealing gasket seems most desirable for all electrical contact units with or without covers.
- Detachable plastic insulating covers would be practical and desirable for the inside surface of electrical

Concept 601: ELECTRICAL CONNECTOR

Primary Bibliography Reference No.: 601

Related Reference Number(s)

Description of Concept

- Multiple-contact unit carried on mating heads of the couplers
- Italian manufacturer

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
*IVA1.	- Multiple-contact unit arranged in support casing - Contact unit is axially slidably mounted in support casing to absorb impact forces during coupling
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 603: AUTOMATIC SERVICE LINE CONNECTOR

Primary Bibliography Reference No.: 603

Related Reference Number(s)

Description of Concept

- Italian Design
- To connect service line conduits for Willison coupler

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	- Mechanical lever system provides for final inter-engagement of the connectors after the frontal impact between coupling heads
IA2.	
*IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
*IVB1.	- Conduits contained in coupler heads
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 605: AUTOMATIC TRAIN LINE CONNECTOR

Primary Bibliography Reference No.: 605

Related Reference Number(s)

Description of Concept

- Connector suspendable from coupler (hangs below coupler)
- Carries air and has potential to carry electric lines
- Gathering wings

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	- Spring loaded to maintain seal
IA2.	
*IA3a.	
*IA3b.	
*IA3c.	
*IB1.	
*IB2.	
*IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
* IVB1.	- Spring holds connectors together
IVB3.	
IVB4.	
* IVB5.	- Electrical connections allow potential for sensing and control systems
* IVB6.	
IVC.	

Concept 606: AUTOMATIC ELECTRICAL PORTION OF SUBWAY COUPLER

Primary Bibliography Reference No.: 606

Related Reference Number(s) 22, 517

Description of Concept

- Electrical connector for subway coupler likely too complex for freight service, but it could be added
- Projected contact pins for non-arcing amperage lines with hermaphrodic fixed socket
- Retractable pin contacts for lines carrying arcing amperages
- Spring loaded

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Fluid pressure advanced, spring-retracted carriage
IVA2.	- Intended to couple without arcing with mating electric coupler without depending upon a drum switch for deengergizing the contacts except when they are coupled
*IVB1.	
IVB3.	
IVB4.	
*IVB5.	
*IVB6.	
IVC.	

Concept 610: RETRACTABLE TRAINLINE CONNECTOR

Primary Bibliography Reference No.: 610

Related Reference Number(s) 502

Description of Concept

- Add on device below coupler
- Spring loaded
- Terminal end shielded when not connected

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	- Retractable when couplers mate
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
*IVB1.	- Retractable when couplers mate
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 611: RETRACTABLE TRAINLINE CONNECTOR

Primary Bibliography Reference No.: 611

Related Reference Number(s) 502

Description of Concept

- Retracted when not connected
- Cover is optional
- Lugs support the device without tilting
- Stop ring limits forward travel; compression spring to maintain connection

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	- Spring loaded retractable device
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
*IVA1.	- Spring loaded retractable device with optional covers
IVA2.	
IVB1.	
IVB3.	
*IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 650: AUTOMATIC COCKING AND RE-COCKING COUPLING

Primary Bibliography Reference No.: 650

Related Reference Number(s)

Description of Concept
- Spring loaded device
- Device mounted below center of car at each side
- Portion of device extends beyond car to be activated from the side of the car by actuating pawls at fixed points along the track

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	X
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	- Device is intended to keep couplers open while uncoupled so that they are always ready for coupling
IIIA2.	
IIIA3a.	
IIIA3b.	
*IIIA4.	
*IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 670: AUTOMATIC HOSE CONNECTION

Primary Bibliography Reference No.: 670

Related Reference Number(s) 511

Description of Concept

- Device to be mounted below coupler
- Gathering funnel to guide head into engagement
- Spring actuated lever

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	- Connection broken automatically by draft forces during car uncoupling
IA2.	- Permits manual operation if desired
IA3a.	
IA3b.	
IA3c.	
*IB1.	
*IB2.	
*IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 671: VALVE MEANS FOR RAILWAY CAR TRAINLINE

Primary Bibliography Reference No.: 671

Related Reference Number(s)

Description of Concept
- Side of car operated telescoping rods extend for universal connections on ball valve to adjacent ends of car
- May be actuated from either side of car
- Ball valve to control airflow

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
* IA3a.	- Ball valve controls air flow
* IA3b.	
IA3c.	- Ball valve is freely floating within the body of the value
IB1.	
IB2.	- Stems extend through the valve body fitting loosely in slots so the valve ball member may move relative to the stems
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 672: AUTOMATIC AIR-COUPLING STRUCTURE

Primary Bibliography Reference No.: 672

Related Reference Number(s)

Description of Concept - Attaches to coupler shank, below coupler knuckle

- Spring-biased air compression cylinder engages aligned air lines upon completion of mechanical coupling
- For cars equipped with conventional draft gear and or end of car cushioning device

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
*IA1.	
IA2.	- Spring loaded cylinder maintains seal
*IA3a.	
*IA3b.	- Ball valve controls air flow
*IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 674: COUPLING VALVE ACTUATOR

Primary Bibliography Reference No.: 674

Related Reference Number(s) 517

Description of Concept

- Valve actuating mechanism to operate a pilot or interface valve
- Force transmitted by hydraulic fluid or flexible push-pull type cable

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	- Hydraulic fluid or push-pull cable used to actuate uncoupling mechanism
IIIA3a.	
IIIA3b.	
IIIA4.	
*IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 676: AUTOMATIC COUPLING SYSTEM

Primary Bibliography Reference No.: 676

Related Reference Number(s)

Description of Concept

- Pair of pilot-operated check valves connected in parallel to the air conduit supplying the actuating means to prevent air flow when main air line is charged but uncoupled at one end

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	- One pilot check valve is operated by air from the means for opening the actuating means and the other is operated by air from the main air line between the main valve and the coupler
IA2.	
IA3a.	
*IA3b.	
*IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 678: AUTOMATIC PNEUMATIC COUPLING SYSTEM

Primary Bibliography Reference No.: 678

Related Reference Number(s) 517

Description of Concept - Extensible pneumatic piston and cylinder assembly, one part is attached to the main body of the coupler; the other part is operally connected to the operating mechanism of the coupler knuckle.

- Bleeding of the cylinder and piston assembly is effected through a pneumatic time delay circuit.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	- Pneumatically - actuated device with control line connected to main air line whereby car uncoupling opens coupler knuckle.
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
* IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 680: TRAINLINE CONNECTOR APPARATUS

Primary Bibliography Reference No.: 680

Related Reference Number(s) 502

Description of Concept - To be carried by railway vehicle coupler

- Arm carrying the connector head can be moved and held in connecting position.
- Can have substantially universal angling movements during trace of the vehicles when the connector is connected.
- Can be held in storage position
- Gathering wings to facilitate connection.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	- Compression spring maintains connection
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 682: AUTOMATIC COUPLING SYSTEM FOR TRAIN BRAKE LINES

Primary Bibliography Reference No.: 682

Related Reference Number(s) 517

Description of Concept
- Attached to coupler below coupler head
- Air coupler on rubber grommet which couples and uncouples simultaneously with mechanical coupling or uncoupling - pilot valves control air.
- Gathering wings facilitate connection.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
* IA1.	- Automatic connection eliminates need for present glad hand system.
IA2.	
* IA3a.	
* IA3b.	
* IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 686: ARMSTED AUTOMATIC AIR LINE CONNECTION SYSTEM

Primary Bibliography Reference No.: 686

Related Reference Number(s)

Description of Concept Consisting of a dual probe/funnel air connection system mounted side-by-side above the coupler head such that the probe "floats" in a "U" shaped mounting and the mating funnel is solidly mounted to the coupler head. The system operates as follows:

1. Coupler guides the probe into basic alignment and the funnel completes the gathering.
2. The probe operates a quick disconnect valve to open its air line with interconnecting air pilot lines.
3. Unintentional uncoupling results in operating of the valves through a spring bias system to set the emergency brake system.
4. With intentional uncoupling, an operating lever (at the valve system) is manually operated or push rod operated to retain air pressure in either or both cars to be uncoupled;

- Automatic air connection and brake valve control.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., IVC.

** There is reason to question the gathering ability of the twin probe/funnel system when coupling on tight curves due to the necessity of the probes to traverse tightly defined parallel paths.

** Ability to maintain the parallel seats under conditions of relative coupler movement (vertical, lateral or rotational) seems doubtful within the travel limits of the "U" shaped mount.

** To operate reliably, the system requires proper operation of both halves of a dual valve control system.

- System does allow an easy use of "mixed" air connection systems since all original angle cocks and hoses remain.

** Complicated uncoupling valve control.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., IIC1., IIC2., IIC3., IID.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., IVC.

Concept 702: ARMSTED MODIFIED DOUBLE SHELF "E" COUPLER

Primary Bibliography Reference No.: 702

Related Reference Number(s)	
Description of Concept	Adaptation of "E" double-shelf coupler (Ref. No. 54) by adding guard arm extension faces at top and bottom of side shelf supports to achieve fixed gathering wings.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Length of front face is extended.
*IIA2.	- Horizontal shelf projects at a distance from longitudinal center line greater than the height of a knuckle.
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Achieves a significant increase in lateral gatherings range (exact amount not quantitatively identified) without sacrifice of interlocking capabilities of "E" double shelf design.
IVA2.	
IVB1.	
IVB3.	- Achieves a nominal increase in vertical gathering.
IVB4.	
IVB5.	
IVB6.	- Increased gathering range would result in a reduced probability for bypasses and, therefore, increased safety.
* IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 703: UNIVERSAL AUTOMATIC COUPLER

Primary Bibliography Reference No.: 703

Related Reference Number(s)

Description of Concept

- One member is a guide member, the other is a locking and guiding member

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 705: HOOK COUPLER

Primary Bibliography Reference No.: 705

Related Reference Number(s) 502

Description of Concept - Spring based coupling hook
- Adapted for interlocking engagement
- Inboard projections and tapered hook facilitate gathering

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	- Tapered hook and inboard projections effects a gathering range of approximately 6"
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 740: COUPLER TO REPLACE HOOK OR SCREW COUPLER

Primary Bibliography Reference No.: 740

Related Reference Number(s) 501

Description of Concept - One piece casting

- Pivotal gathering wings disposed at a 45° angle from a horizontal plane.
- Head at one end of the shank provided with upper and lower sections defining a throat.
- Lock mounted in upper section latch on one gathering wing.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
* IIA3.	
IIB1.	- Wings increase gathering
* IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
* IIIA1.	- Lock intended to prevent unintentional uncouplings
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
* IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 760: MODIFIED "E" COUPLER

Primary Bibliography Reference No.: 760

Related Reference Number(s) 502

Description of Concept - Improved lever member having roller contact with an associated cam element to improve opening coupler

- Spring actuated

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
*IIIB1.	- Spring actuated lever member within the coupler head
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 761: MODIFIED KNUCKLE COUPLER

Primary Bibliography Reference No.: 761

Related Reference Number(s) 502

Description of Concept - Knuckle coupler

- Spring assembly to actuate the knuckle unlocking and opening.
- Assembly easily removed for maintenance purposes.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
*IIIB1.	- Spring loaded assembly facilitates lock opening.
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 890: IMPROVED KNUCKLE STRUCTURE

Primary Bibliography Reference No.: 890

Related Reference Number(s) 501, 502a

Description of Concept - Knuckle coupler
- Convex gathering surface

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	- Improved knuckle contour to improve gathering.
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 891: COUPLER KNUCKLE STRUCTURE

Primary Bibliography Reference No.: 891

Related Reference Number(s) 501

Description of Concept - Knuckle coupler with gathering surfaces.

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	- Couplers may be misaligned by as much as 4-1/8 inch.
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 892: COUPLER CONTOUR

Primary Bibliography Reference No.: 892

Related Reference Number(s) 502

Description of Concept - Knuckle coupler with modified 10A contour wherein pulling face of its pivoted knuckle is offset approximately 5/64 inch closer to the front face of the coupler head.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
* IIB2.	- 20% reduction of free slack.
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 895: CAR COUPLER

Primary Bibliography Reference No.: 895

Related Reference Number(s)

Description of Concept

- Knuckle contour to facilitate gathering

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"
2. Requires modification of Type "E"
3. Requires head adapter for Type "E"
4. Incompatible with Type "E"

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	- Knuckle contour facilitates gathering
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 900: RAILWAY CAR COUPLER

Primary Bibliography Reference NO.: 900

Related Reference Number(s)

Description of Concept

- Auxiliary lug is mounted on shelf carried on the lower portion of the coupler head

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
*IIA1.	
*IIA2.	- Auxiliary lug has ramp portion to slidably engage the bottom forward edge of a shelf carried by an opposed mating coupler to permit coupler alignment
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 901: COUPLER KNUCKLE

Primary Bibliography Reference No.: 901

Related Reference Number(s)

Description of Concept

"F" Knuckle - Provision of a pair of spaced lugs on the knuckle arranged for full face engagement with existing shoulders of coupler head

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	- Greatly increase bearing areas between knuckle and coupler head - Claims to reduce failures because the lugs strengthen the nose
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 910: INTERLOCKING KNUCKLE COUPLER

Primary Bibliography Reference No.: 910

Related Reference Number(s)

Description of Concept - A spring loaded latch is attached to a coupler to slip into a space on the opposite coupler to provide vertical interlock even if only one coupler is equipped.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
*IIB3.	- Latch slips into a space on the opposite coupler to prevent vertical movement.
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 912: "F" COUPLER HOOD

Primary Bibliography Reference No.: 912

Related Reference Number(s) 502

Description of Concept - "F" coupler hood which overlies the knuckle - receiving recess of the "F" coupler to afford vertical interlock when coupled with an "E" coupler.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
*IIB3.	- Coupler hood overlies the knuckle.
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 913: VERTICALLY INTERLOCKING COUPLER

Primary Bibliography Reference No.: 913

Related Reference Number(s) 501

Description of Concept - Knuckle coupler with vertical interlock shelf having a recess for receipt of the lower auxiliary interlock lug of a type "F" coupler.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	X
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM	
Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING	
Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
*IIB3.	- Shelf has recess for "F" interlocking lug.
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING	
Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS	
Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 940: BRUSH UNCOUPLER

Primary Bibliography Reference No.: 940

Related Reference Number(s)	
Description of Concept	- A brush apparatus located alongside the track which provides the traditional manual function of pulling the lever to uncouple knuckle couplers.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	N/A
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
*IIIB1.	- Brush against coupler release lever has effect of pulling the lever manually.
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 943: FLUID OPERATED UNCOUPLING MECHANISM

Primary Bibliography Reference No.: 943

Related Reference Number(s) 517

Description of Concept
- Fluid operated uncoupling mechanism mechanically connected to the longitudinally swingable part of the coupler's locklift assembly
- Includes an actuator mountable on a head of the coupler having a pressure-advanced, spring returned piston connected to an operating shaft

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
*IIA3.	- Positive locking provided even with pressure failure
*IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	- Fluid operated actuator attached to the uncoupling mechanism
IIIA3b.	
*IIIA4.	
*IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 960: UNCOUPLER LEVER

Primary Bibliography Reference No.: 960

Related Reference Number(s)	508
Description of Concept	- Lever assembly for cars equipped with standard draft gear. - Avoids substantial movement of lever handle.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
*IIIA1.	- The portion of the handle section bar projecting inboard of the car from the slideway forms the portion of the adjuster accommodating take-up and let-out of the effective length of the lever assembly as required by coupler swing and impacts.
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1020: UNLOCKING DEVICE FOR COUPLERS

Primary Bibliography Reference No.: 1020

Related Reference Number(s)

Description of Concept

- Japanese design
- Device for lifting cotter pins

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	- Unit mounted at side of track
IIIA3a.	
*IIIA3b.	- Uses a boom mechanism to pull pins
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1043: SYSTEM FOR AUTOMATIC CONNECTION RELEASE

Primary Bibliography Reference No.: 1043

Related Reference Number(s) 1044

Description of Concept

- Japanese invention.
- Combination of electrical and penumatic controls in which a line for supplying air under pressure extends from locomotive to the cars to disconnect any desired car by air pressure force.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
*IIIA1.	- Pneumatic signal from locomotive releases coupler.
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1044: REMOTE CONTROL CAR RELEASE

Primary Bibliography Reference No.: 1044

Related Reference Number(s) 1043

Description of Concept

- Actuating air supply line and instruction air line are connected from locomotive through the train.
- Operator manipulates on-off control valve in the locomotive by the number of times corresponding to the car number of the desired car to be disconnected.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
*IIIA1.	- Remote control air pressure.
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1045: HINES ELECTRIC UNCOUPLING SYSTEM

Primary Bibliography Reference No.: 1045

Related Reference Number(s)	
Description of Concept	Control system consists of a locomotive control box (car selector switch, rotary self-interrupting stepping switch, relays and operating switches), four individual circuit wires between cars and individual car control boxes (two stepping relays and two coupler unlatching solenoids);

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
*IIIA3a.	- Feasible system if: (1) uncoupling can be accomplished by force from a solenoid and (2) solenoids can be adequately protected from malfunction from environment.
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	- Compatible as part of add-on control system.
IVA2.	
IVB1.	
IVB3.	- Feasible control system if: (1) electric intercar connection system available, (2) electric solenoids are available with capacity to meet force required to operate uncoupling valves while being sensitive enough to react to control pulses and (3) relay and stepping switches which are reliable under the required environment.
IVB4.	
IVB5.	
* IVB6.	
* IVC.	- Remote uncoupling will improve reliability.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 1046: FLUID OPERATING UNCOUPLING MECHANISM

Primary Bibliography Reference No.: 1046

Related Reference Number(s) 517

Description of Concept
- Liquid-operating uncoupling mechanism
- Requires no operating slack
- Can be operated conventionally from side of car or automatically

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

- Applicable for cushioned underframe cars
- Positive locking in the event of failure

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
* IIA3.	- Positive locking in the event of failure retains this feature even with fluid pressure failure
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
* IIIA1.	- To unlock the coupler a solenoid is energized to turn valve to a position in which its inlet port is connected to its advance outlet port
IIIA2.	
* IIIA3a.	
IIIA3b.	
IIIA4.	
* IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1061: UNCOUPLING LEVER

Primary Bibliography Reference No.: 1061

Related Reference Number(s)

Description of Concept - Lever for cars equipped with impact absorbing device where there may still be substantial relative movement between center sill and the coupler and car body

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
*IIIA1.	- Operated from side of car which has a part connected to the coupler accommodating substantial longitudinal and some rotational movement of the coupler relative to the car frame
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1063: UNCOUPLING LEVER

Primary Bibliography Reference No.: 1063

Related Reference Number(s)

Description of Concept

- Uncoupling lever designed to accommodate long travel of cushioned sliding sill cars

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
*IIIA1.	- Designed to accommodate telescopic movement of a sliding sill
IIIA2.	
IIIA3a.	- Adapted for mounting along a sliding sill structure
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1070: ACTUATING DEVICE FOR WHEEL GUIDANCE

Primary Bibliography Reference No.: 1070

Related Reference Number(s)	
Description of Concept	- Spanish design - To bypass difficulties during coupling or uncoupling of vehicles provided with guided wheels by providing simple bumper like device - Bumpers are spring mounted

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	X

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
*IIC1.	- Wheel guidance
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1100: COUPLER POSITONING DEVICE

Primary Bibliography Reference No.: 1100

Related Reference Number(s) 508

Description of Concept

- Swing lever positioned between the coupler and the car truck
- Uses cable structures extending between the respective ends of a swing lever and coupler shank - each includes preloaded tension springs to adjust the bias of the coupler into alignment

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	- Swing lever with cable structures and spring loaded tension springs to keep coupler tangent to track
IIC1.	
IIC2.	
*IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1101: COUPLER POSITIONING DEVICE

Primary Bibliography Reference No.: 1101

Related Reference Number(s) 508

Description of Concept - Positioning device for sliding sill underframe car

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	- Coupler connected to end of swing lever by uncushioned cable connection; connecting cables are trained over sheaves at respective ends of the swing lever for connection to a shock absorbing device
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
*IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1140: MAGNETIC COUPLER

Primary Bibliography Reference No.: 1140

Related Reference Number(s)

Description of Concept

- Electromagnet at outer end of a piston rod of a double acting pneumatic cylinder
- Electromagnet coupling a car to an armature of an adjoining car
- Pneumatic cylinder serves to absorb the shock of the coupling impact and to draw the cars together

Compatibility with AAR Type "E" Coupler:

1. Can be added to Type "E"	
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	Electromagnet helps draw the cars together
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1150: REMOTE CONTROL CAR UNCOUPLER

Primary Bibliography Reference NO.: 1150

Related Reference Number(s)

Description of Concept - Magnet device mounted in track to pull open coupler - position of coupler is sensed through photoelectric cell devices located at each side of track.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
* IIA1.	- Magnet insures that the coupler is always open and ready for coupling.
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	
IVB1.	
IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Concept 1160: ELECTRICAL CIRCUIT CONTROL APPARATUS

Primary Bibliography Reference No.: 1160

Related Reference Number(s)

Description of Concept
- Spring loaded contact pin for making and breaking circuits
- Not subject to electrical shock potential if exposed to weather
- Electrically insulated block assembly

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	
IVA2.	- Spring loaded contact pin maintains connection
*IVB1.	
IVB3.	- Has potential for advances in control and sensing systems
IVB4.	
*IVB5.	
*IVB6.	
IVC.	

Concept 1190: KEYSTONE CENTERING DEVICE

Primary Bibliography Reference NO.: 1190

Related Reference Number(s)

Description of Concept

Coupler self-centering device utilizing the buffing force of the draft gear return spring to apply bias force to lateral extended bearing surfaces on the shank butt. Lateral movements of the shank cause the bearing forces to shift from the normal spherical mating surfaces (matched between butt and yoke) to the lateral lips on the butt and yoke. The return spring applies the bias force to the shank to aid centering.

Compatibility with AAR Type "E" Coupler:

1.	Can be added to Type "E"	X
2.	Requires modification of Type "E"	
3.	Requires head adapter for Type "E"	
4.	Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions: IA1., IA2., IA3a., IA3b., IA3c., IB1., IB2., IB3.

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions: IIA1., IIA2., IIA3., IIB1., IIB2., IIB3., IIB4., *IIC1., *IIC2., IIC3., IID.

- Compatible as part of revised draft gear system.
- Self centering would be effective for recentering of lateral movements (beyond a designed "free force" center range). Greater buff forces (i.e., during emergency stops) would result in greater centering forces; therefore, reducing contour angling tendancy the greatest under emergency stop conditions.
- Simple, maintenance free, full-time centering device for long car application.

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions: IIIA1., IIIA2., IIIA3a., IIIA3b., IIIA4., IIIB1., IIIB2.

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions: IVA1., IVA2., IVB1., IVB3., IVB4., IVB5., IVB6., IVC.

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

Concept 1200: WABCO AIR CONNECTOR

Primary Bibliography Reference No.: 1200

Related Reference Number(s) 511

Description of Concept

Wabco air connector with electrical contactor (automatically positioned by air connector unit - such as Ref. 511b - and electrical contacts moved into or from mating position by following sequences:

1. Seating of guide arm operates a valve in mating connector.
2. Valve channels air line pressure (as quickly as available) to actuate a piston.
3. Piston thrusts the clustered contact pins forward into mating pisition.
4. Release of air pressure allows contacts to disengage from return spring pressure.

Compatibility with AAR Type "E" Coupler:	
1. Can be added to Type "E"	X
2. Requires modification of Type "E"	
3. Requires head adapter for Type "E"	
4. Incompatible with Type "E"	

CATEGORY I - IMPROVE TRAIN AIR-LINE SYSTEM

Pertinent Functions	
IA1.	
IA2.	
IA3a.	
IA3b.	
IA3c.	
IB1.	
IB2.	
IB3.	

CATEGORY II - IMPROVE MECHANICAL COUPLING

Pertinent Functions	
IIA1.	
IIA2.	
IIA3.	
IIB1.	
IIB2.	
IIB3.	
IIB4.	
IIC1.	
IIC2.	
IIC3.	
IID.	

CATEGORY III - IMPROVE MECHANICAL UNCOUPLING

Pertinent Functions	
IIIA1.	
IIIA2.	
IIIA3a.	
IIIA3b.	
IIIA4.	
IIIB1.	
IIIB2.	

CATEGORY IV - IMPROVE GENERAL SYSTEMS

Pertinent Functions	
IVA1.	** Proper operation of contacts is dependent on (1) adequate air pressure, (2) proper operation of complex air valve and (3) movement of sliding cylinder to move contact block into position.
IVA2.	
* IVB1.	** Number of contacts is limited to cross-section of a sliding piston.
* IVB3.	
IVB4.	
IVB5.	
IVB6.	
IVC.	

Notes: *This concept embodies improvements in this function.
**Denotes potential operating or safety problem.

C.3 DATA ACCUMULATION FORM

SIGNIFICANT COUPLER CONCEPT DATA

GENERAL SUMMARY

1) Concept Description and Model No. ____________________

____

2) Manufacturer ________________________________

3) State of concept development (check as applicable)

   (a) Conceptual (pat. pen.) __________

   (b) R & D Phase Complete __________

   (c) Engineering prototype tested __________

   (d) Field test completed __________

   (e) Ready for pilot production __________

   (f) In production __________

4) Environmental limitations (list differences from "E" coupler capabilities for: temperature, dirt or dust, vibration or impact damage susceptibility etc.) ____________________

____

5) Compatible with AAR type "E" coupler system? __________

6) Estimates of costs (based on 1975 dollars).

   (a) Cost $_____ and time ____ (months) to bring the concept up to a state of "ready for pilot production"

   (b) System purchase price $_____ (based on ____ units/year)

   (c) System installation costs for: New construction $_____ and retrofit on old cars $_____ (cost/car)

   (d) System maintenance $____ (est. average maintenance cost per year - annualized over first 10 years)

7) Summary of Functional Characteristics (attach detail data sheets.

	Mechanical Functional Category			
Bibliography Ref. No.	I-Air Line System (Sheet 2)	II-Mechanical Coupling (Sheets 3 & 4)	III-Mechanical Uncoupling (Sheet 5)	IV-General Systems (Sheet 6)

FUNCTIONAL CHARACTERISTIC DATA SHEET

CATEGORY I - IMPROVE TRAIN AIR LINE SYSTEM

	System Capability Yes	System Capability No
Automatic Control		
1) Automatic connection with coupling	___	___
2) Provide second air line system	___	___
3) Automatic operation of air valves	___	___
(a) Coupling - open valves	___	___
(b) Uncoupling (intentional) - close valves	___	___
(c) Uncoupling (unintentional) - open valves	___	___
Improved Performance		
1) Improved integrity of air seal (lower leak rates or gasket wear rates)	___	___
2) Improved hose reliability against breakage, damage, or failure	___	___
3) Reduce hose and/or glad hand maintenance cost	___	___

General Data (as applicable to explain concept capabilities)

(a) Method of attachment of air connection system: ______

____

(b) Air line size(s) and capacity: ______________

____

(c) Describe operation of air attachment system: ______

____

____

(d) Describe air valve operation: ______________

(e) Explain reasons for improved reliability or reduced maintenance: ______________

____

FUNCTIONAL CHARACTERISTIC DATA SHEET

CATEGORY II - IMPROVE MECHANICAL COUPLING

(As Compared to AAR Type "E" Coupling System)

	Improve Yes	Improve No
Automatic Engagement without Assistance		
1) Improve lateral gathering range (one coupler open, actual = ± _____ in; both couplers open, actual = ± _____ in.)	___	___
2) Improve vertical gathering range (actual = ± _____ in.)	___	___
3) Positive locking of mated couplers	___	___
How accomplished? ______________________________		
Positive Retainment of Mated Couplers		
1) Positive coupling at wider speed range (actual from _____ to _____ mph.)	___	___
2) Reduce free slack (actual slack of mated couplers = _____ in.)	___	___
3) Vertical interlock	___	___
4) Absolute entrapment of broken coupler	___	___
How accomplished? ______________________________		
Coupler Location Control System		
1) Self centering	___	___
How accomplished? ______________________________		
2) Reduced contour angling capability	___	___
How accomplished? ______________________________		

CATEGORY II (CONT'D.)

	Improve Yes	Improve No
3) Automatic positioning	___	___

Describe system ______________________________________

____

Reduced Maintenance Requirements	___	___

How accomplished? ______________________________________

____

General Data (as compared to AAR type "E" coupling system):

1) System Strength Limitations: Buff ______ lbs., Draft ________ lbs. Coupler Unit Weight ____ lbs., Draft Strength/Coupler Weight Ratio = ____________

2) Envelope dimensions ______________________________________

____

3) Coupled movement limits: Lateral swing ____________ Vertical swing _______ Angular rotation ____________

4) Response time required for contract of mating couplers to achieve complete coupling: ____________

____

____

5) Describe general coupling sequence: ____________

____

____

6) Describe expected wear points as related to ultimate coupler failure mode: ____________

____

____

FUNCTIONAL CHARACTERISTIC DATA SHEET

CATEGORY III - IMPROVE MECHANICAL COUPLING

(As Compared to AAR Type "E" Coupling System)

	Improve Yes	Improve No
Improve Uncoupling Capability		
1) Alternate Side Lever	___	___
2) Side of car (push button) release	___	___
How accomplished? ______________________		
3) Automatic release from:		
(a) Within train	___	___
(b) External to train	___	___
4) Uncoupling in draft	___	___
How accomplished? ______________________		
Force Required? ______________________		
Improve Recoupling Capability		
1) Knuckle automatically opened at uncoupling	___	___
How accomplished? ______________________		
2) Other (explain) ______________________	___	___

General Data (as compared to AAR type "E" coupling system)

1) Describe coupling sequence: ______________________

2) Other comments: ______________________

CATEGORY IV - IMPROVE GENERAL SYSTEMS

	System Capability Yes	No
Automatic Brake Control with Uncouplings	___	___
1) Intentional uncoupling (with time delay provisions)	___	___
2) Unintentional uncoupling (emergency set)	___	___
Describe operation of brake control system: ______________________		
Electrical Train Line System		
1) Automatic connection make and break	___	___
Describe system ______________________		
2) Circuit capacities--(number, amps, volts) ______________________		
3) Automatic sequencing of contactors	___	___
Describe system ______________________		
4) Full environment protection of contactors	___	___
How? ______________________		
5) Train sensing systems (list capabilities)	___	___
______________________		
6) Train control systems (list capabilities)	___	___
______________________		
Improve Operational Safety	___	___
How? ______________________		

APPENDIX D

BIBLIOGRAPHY

D.1.1 INFORMATION RETRIEVAL SEARCH TOPICS

1) Alignment Control
2) Automatic Coupler
3) Automatic Lock Set
4) Centering Device
5) Coupled
6) Coupler
7) Coupler, Type E
8) Coupler, Type F
9) Coupling
10) Coupling Circuit
11) Drawbar
12) Freight Car
13) Knuckle
14) Passenger Car
15) Positioning Device
16) Railroad
17) Railroad Car
18) Railroad Train
19) Self Aligning Coupler
20) Vertical Interlock
21) Vertical Separation Control

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D.1.2 BIBLIOGRAPHY

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D.2.1 RAILROAD INDUSTRIES INTERVIEWED

Bibliography Reference No.	Railroad Industry Source Interviewed	Page
501	American Steel Foundry	D - 29
502	Midland Ross Corporation National Castings Division	D - 29
503	Ohio Brass Corporation	D - 30
504	General Foods Corporation	D - 30
505	Canadian Steel Foundries	D - 31
506	Hawker Siddley - Thunder Bay	D - 31
507	Stanray Corporation	D - 32
508	Holland Company	D - 32
511	Westinghouse Air Brake Company	D - 32
513	Dominion Foundries and Steel Limited	D - 33
514	New York Air Brake	D - 33
515	Freight Master	D - 34
516	Walton Products	D - 34
517	Dresser Transportation Equipment	D - 35
551	San Francisco Bay Area Rapid Transit System	D - 35
552	Cleveland Transit System	D - 35
553	Southern Railway	D - 36
554	New York City Transit Authority	D - 36
555	Chicago Transit Authority	D - 36
556	Atchinson, Topeka and Santa Fe Railroad Company	D - 37
557	Washington Metropolitan Transit Authority	D - 37
558	Toronto Area Transit Operating Authority	D - 37
559	Canadian National Railways	D - 38

D.2.2 SUMMARIES OF INTERVIEWS

Bibliography Reference No.	Industry Interviewed
501	American Steel Foundry 1005 Prudential Plaza Chicago, Illinois (312) 644-4080

Interview discussions included centering and positioning device issues, coupler modifications to increase the gathering range, and general research and development activities in the railroad industry.

Efforts to increase the coupler gathering range consist of changing the contour of the coupler knuckle, knuckle location and guard arm location.

The impact of mass transit couplers and proprietary couplers used on unit trains and in dedicated service was also discussed.

502	Midland Ross Corporation National Castings Division 2570 Woodhill Road Cleveland, Ohio 44104 (216) 229-3400

National Castings "Compatamatic" coupler was explained in detail. The "Compatamatic" is an "add-on" device which can be used with an "E" or "F" coupler. An automatic airline system can be included with the "Compatamatic." While cost estimates were discussed, because the device is still in the prototype stage, exact costs could not be quoted.

A contract was granted to National Castings in conjunction with European firms for conversion to the Willison (UIC) coupler. Characteristics of the coupler were explained and related to the "E" and "F" couplers.

Other National Castings activities and interests include knuckle contour modification, coupler strength enhancement, slack reduction, and locking and lock set.

503 The Ohio Brass Company
Mining and Transit Department
Mansfield Division
380 North Main Street
Mansfield, Ohio 44902
(419) 522-7111

A review was made of the current and past activities on the part of Ohio Brass in the area of railroad and mine car couplers. The type of designs which were reviewed include rigid, flat faced, matching horn/funnel, hinged hook type couplers, rigid, nonreversible type, male/female couplers, coupler location control systems, and coupler electrical systems.

504 General Foods Corporation
White Plains, New York
(914) 253-4452

The General Foods proposed Integral Container Train (ICT) was discussed. An "F" coupler with thirty-six inch draft gear is used for inter-car coupling. Details of the intra-car connectors are not defined at this time; however, they are expected to be a slight modification of connectors used in the Southern Railroad "auto-guard" car. Generally, these would be eight-foot long tubular draw bars with service shank pins.

505 Canadian Steel Foundries
Division of Hawker Siddley
Canada, Ltd.
P. O. Box 80
Montreal, Quebec HIU 3L7
(514) 255-4041

Canadian Steel Foundries, a coupler manufacturer for the rail freight industry, is a division of National Castings. Accordingly, all coupler work related to research and development is conducted by National Castings under the direction of Mr. Damiano Albanese.

506 Hawker Siddley Canada, Ltd.
Thunder Bay, Ontario
(807) 577-8431

Hawker Siddley, a major manufacturer of mass transit railcars, does not develop nor manufacture couplers for their mass transit cars. Instead, coupling systems, as specified by the mass transit users, are subcontracted out to either Waugh (Dresser), WABCO, or Ohio Brass. Thus, information regarding mass transit couplers and their components used by Hawker Siddley can be obtained only from these subcontractors.

Bibliography Reference No.	Industry Interviewed
507	Stanray Corporation Standard Railway Equipment Division 4527 Columbia Avenue Hammond, Indiana 46320

Stanray's primary involvement with coupler systems focuses on centering devices and coupler release rods.

Their current centering devices use leaf spring and single spring principles. The devices are usually installed on new cars rather than retrofit. The expected life of a centering device is eight years.

Two primary problems identified with centering device utilization is force and friction moving the coupler to center. The primary advantage gained in using centering devices is a reduction in end of car damage due to by-passed couplers.

508	Holland Company 747 East Roosevelt Road Lombard, Illinois 60148

The Holland Company has developed and at one time marketed a coupler positioning device. The functions of the positioning device were explained in detailed and operations were demonstrated through several films.

Economic issues were presented including purchase, installation, and maintenance estimates.

511	Railroad Products Marketing WABCO - Westinghouse Air Brake Company Wilmerding, Pennsylvania 15148

Bibliography Reference No.	Industry Interviewed

The WABCO N2 and N2A mass transit couplers were discussed in detail. Specific issues pursued were the construction and repair of the devices, pneumatic coupler operation, and the use of centering devices.

An automatic air connector to be used in conjunction with National Casting's "Compatimatic" was explained. Conceptually, the devices would supplement the current air line system to provide compatibility for cars not equipped with the device.

Potential for electrical connections in freight service was discussed in light of current WABCO research and development activities.

513 Dominion Foundries and Steel Ltd.
P.O. Box 460
Hamilton, Ontario
Canada LBN 3J5

DOFASCO manufactures couplers to design specification, but has no coupler research and development activity. Accordingly, interview topics centered upon coupler manufacturing considerations - casting and machining components and strength of materials issues.

514 New York Air Brake
Starbuck Avenue
Watertown, New York 13601

New York Air Brake develops and manufactures braking systems for passenger, rapid transit, and freight trains. End of car equipment reviewed during the plant visit was brake pipes, angle

Bibliography

Reference No. | Industry Interviewed

cocks, and air hoses. Considerations for including electrical connections within the freight air line system appears reasonable with NYAB developments.

This company is expanding the rapid transit business through import of a German coupler - the BSI coupler. Air system simulators and an operational model of the BSI coupler were available for demonstration.

515 Freight Master
P.O. Box 40555
Ft. Worth, Texas 76140

The primary railroad product manufactured by Freight Master is the hydraulic end-of-car cushioning device.

Interview commentary included an explanation of the use of the devices, cost, installation, and maintenance considerations. Of particular interest were the special modifications affecting air systems and coupling systems such as special glad hand travels with some units.

516 Walton Products
868 Sussex Boulevard
Broomall, Pennsylvania 19008

The Walton Electro-Pneumatic Coupling System and the Walton electrical system for rapid transit couplers were presented. The discussions included detail related to design considerations and operating characteristics of the coupler and electrical systems.

A model was available for demonstration purposes.

Bibliography Reference No.	Industry Interviewed
517	Dresser Transportation Equipment Two Main Street Depew, New York 14043

Dresser manufactures both freight and rapid transit couplers and conducts research and development activities related to coupling systems. Several models are displayed for demonstration purposes.

In addition to the couplers, concepts behind the development efforts for their automatic trainline connector and their positioning device were reviewed.

551	San Francisco Bay Area Rapid Transit 800 Madison Street Oakland, California 94615 (415) 465-4100

Operating characteristics of the current BART system couplers were presented from the users viewpoint. Problems with the coupler system were identified with the electrical system, the draft gear, and springs. In relating the BART coupler system to its potential for freight service, coupler strength was considered the major issue.

552	Cleveland Transit System 3420 East 93rd Street (216) 781-5000

The Cleveland Transit System coupler use and related problems were reviewed. Problems confronting the system are damage to electrical components upon coupling and ice and snow effects.

Bibliography
Reference No. — Industry Interviewed

553 Southern Railway
409 Henry Street
Alexandria, Virginia

Knuckle failure was identified as a major problem with "E" couplers particularly with high load unit trains. Other problems are draft gear and yoke related and air hose connections and leakage.

It was felt that air connection enhancements should be given top priority for improving the overall freight coupling system.

554 New York City Transit Authority
370 Jay Street
Brooklyn, New York 11201

The New York City Transit Authority has approximately seven thousand cars in service. The mechanical portion of the coupler presents no operational nor maintenance problems. The only suggestion for improving the coupling system was enhancing the electrical system possibly through the use of multiplexors.

555 Chicago Transit Authority
Chicago, Illinois
(312) 664-7200

The Chicago Transit Authority uses couplers supplied by Ohio Brass. It was felt that the manufacturer could provide information pertinent to this study.

Bibliography Reference No.	Industry Interviewed

556 Atchison, Topeka and Santa Fe Railroad Co.
80 East Jackson Boulevard
Chicago, Illinois 60604
(312) 427-4900

Problems with "F" couplers were identified as weak pin connection causing coupler detachment and potential for derailment and jackknifing in buff compression. "E" couplers cannot hold a broken mated coupler, has considerable wear potential, and considerable slack.

The use of the "Compatimatic" device and positioning devices were discussed in addition to potential for automatic air connections and electrical lines for freight service.

557 Washington Metropolitan Transit Authority
600 Fifth Street, N.W.
Washington, D.C.
(202) 637-1234

Washington Mass Transit Authority has a unique remote coupling capability on their system. The primary problem experienced with their coupling process is by-passed couplers and coupler alignment.

558 Toronto Area Transit Operating Authority
3625 Dufferin Street
Downsview, Ontario M3K 1C2

Toronto Area Transit Operating Authority currently uses "H" couplers on their passenger trains. Because an objective is to

Bibliography
Reference No. Industry Interviewed

reduce manual effort required in coupling operations they are evaluating new couplers for future installation.

Problems confronting them were reviewed and include slack action, power cable flexing, and flexing and worn air hoses.

559 Canadian National Railways
935 Lagauchetiere Street, West
Montreal, Quebec, Canada H3C 3N4

The primary problem experienced with the freight couplers on the Canadian National Railways system is knuckle breakage and long cars are highly subject to miscoupling damage.

Center devices have been used successfully on the cars to reduce the incidence of by-passed couplers.

Potential for electrical system installation in freight service was reviewed and endorsed.

D.3.1 PATENT CLASSES

Class - Subclass		Title
213	-	Railway Draft Appliances
	1.3	Combined coupler and electric connector
	1.6	. with additional circuit-making or braking means
	15	Cushioned, truck controlled
	20	Cushioned, centering devices
	75	Couplings
	75A	. Operated by trackside mechanism
	75B	. Mine car
	75TC	. Toy train
	75D	. Magnetic
	76	. Combined car and train line
		Couplings, Counterpart
	100R	. . Interengaging hooks or knuckles
	100W	. . . . Willison coupler
	101	. . . Arrowhead type
	102	. . . . Plural
	103	. . . Transversely sliding bill
	104	. . . Horizontally swinging
	105	. . . . Miller hooks
	106	. . . . . Movable bill
	107	. . . . Star wheel
	108	. . . . Plural
	109	. . . . Janney type
	110	. . . . . Always in coupling position
	111	. . . . . Auxiliary and emergency
	112	. . . . . . Transition construction and devices

Class	Subclass	Title
213	113	. . . . . Plural-tailed knuckles
	114	. . . . . Pinless knuckles
	115	. . . . . Knuckle openers
	116	. . . . . . Springs
	117	. . . . . . Gravity
	118	. . . . Knuckles
	119	. . . . . . Combined locks
	120	. . . . Vertically movable and horizontally rotatable
	121	. . . . Vertically movable and tilting
	122	. . . . Vertically sliding
	-	<u>COUPLINGS</u>
		. <u>Counterpart</u>
		. . Interengaging hooks or knuckles
		. . . Horizontally swinging
		. . . . Janney type
		. . . . . Knuckle openers
		. . . . . . Combined locks
		. . . . Vertically sliding
	123	. . . . Pivotally-attached member
	124	. . . . Pivoted or rotatable
	125	. . . . . . Lock operated
	126	. . . . Vertically-sliding locks
	127	. . . . And rearwardly swinging
	128	. . . . Vertically-swinging levers
	129	. . . . Vertically-swinging locks
	130	. . . . Horizontally-sliding locks
	131	. . . . . . Lock operating
	132	. . . . Continuing movement
	133	. . . . Horizontally-rotating shaft

Class	Subclass	Title
213	134	. . . . Pivoted levers
	135	. . . . Sliding
	136	. . . . Vertically
	137	. . . . Separate movement
	138	. . . . Rotating and sliding
	139	. . . . . . Gravity locks
	140	. . . . Knuckle attached
	141	. . . . Vertically swinging
	142	. . . . With lock set and anticreep
	143	. . . . With lock set
	144	. . . . With anticreep
	145	. . . . Vertically sliding
	146	. . . . With lock set and anticreep
	147	. . . . With lock set
	148	. . . . With anticreep
	149	. . . . . . Horizontally-sliding locks
	150	. . . . . . Horizontally-swinging locks
	151	. . . . . . Contour
	152	. . . . . . Knuckle and head interengagement
	153	. . . . . . Vertical-disengagement prevention
	154	. . . . . . Guard-arm construction
	155	. . . . . . Knuckle and knuckle pins
	156	. . . . . . Knuckle-pin bottom retainers
	157	. . . . . . Detachable ears
	158	. . . . . . Lifter and lock-hole closures
	159	. . . . . . Uncoupling devices
	160	. . . . Emergency
	161	. . . . Selectively movable
	162	. . . . Pull rods, chains or ropes
	163	. . . . Interengaging levers
	164	. . . . Vertically swinging

Class - Subclass		Title
213	165	. . . . . . Vertically swinging
	166	. . . . . . Rotating horizonital shafts
	167	. . . . Journaled to coupler head
	168	. . . . Directly connected to lock
	169	. . . . Horizontal link to lock
	170	. . . . Vertical link to lock
	171	. . . . . . Brackets
	172	. . . Vertically swinging
	173	. . . . Vertical hook
	174	. . . Rotating
		<u>Couplings, Link or Bar type</u>
	175	. . Hook and catch
	176	. . Beveled link and swing catch
	177	. . . Arrowhead
	178	. . Hook and link
	179	. . . Pivoted hook
	180	. . . . Multiple
	181	. . . Rails
	182	. . Headed link and shouldered slot
	183	. . . Pivoted head
	184	. . . Rotating head or link
	185	. . Beveled link and sliding catch
	186	. . . Arrowhead type
	187	. . Beveled link and fixed catch
	211	<u>Couplings, Uncoupling Devices</u>
	212	. . Central control
	213	. . Operable from car top to side
	214	. . . Rotating vertical shaft
	215	. . Operable from car top only
	216	. . Rotating vertical shafts
	217	. . Flexible
	218	. . Vertical swinging lever
	219	. . Rotating horizontal shafts

Class - Subclass		Title
105	-	Railway Rolling Stock
	2	
	3	
	4	
180	-	Motor Vehicles
	14	
188	-	Combinations of Couplers and Brakes
214	-	Material or Article Handling
280	-	Land Vehicles
	400	

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APPENDIX E

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APPENDIX F

REPORT OF INVENTIONS

This report, a survey and assessment of automatic coupling concepts for rail freight cars, includes as Appendix C a previously unavailable listing and categorization of automatic coupling concepts. Section 5 provides estimated quantitative values of improvement in coupling systems from each concept. Cost estimates for candidate coupling systems composed of various concepts are found in Section 6 and they represent a new contribution.

APPENDIX G

PRELIMINARY DEVELOPMENT SPECIFICATION FOR AUTOMATIC TRAIN AIR LINE CONNECTOR

A.1 GENERAL PROVISIONS

1) Installation of the connector to the car must be possible with the coupler in place. Mounting must not interfere with existing car components (including hydraulic cushioning devices on long cars).

2) Connector must be suitable for mounting on both Type "E" and "F" couplers (including a double-shelf "E" coupler and a top shelf "F" coupler).

3) Replacement of damaged connector, or components, must be accomplished with a minimum of time and with no special tools.

4) Connector mounted to a car must not exceed clearance limits and must operate satisfactorily at the track curvature limits specified for freight cars in the AAR Manual of Standards and Recommended Practices. (Section C, pages C-4-1968 through C-7-1968, and in the AAR Specifications for Design, Fabrication and Construction of Freight Cars.) Connector must not restrict air flow through the brake pipe at the limits specified.

5) Connector must allow making a manual brake pipe connection from the connector face to a car having standard air brake hose.

6) Connector must be suitable for freight car service between temperatures of -50°F to 200°F.

7) Connector must not normally require periodic attention except for replacement of hose coupling gasket and hose.

8) Connector must operate within a pressure range of 0 to 150 psi.

9) Cost objectives must be compatible with satisfactory operating requirements.

10) Connector design shall provide space for a mechanical push-rod which is depressed by the full closure of the butt seal. (This push-rod will be incorporated as a part of a separate air valve control mechanism.)

A.2 CONNECTION PROVISIONS

1) Connector concept must be suitable for installation of one air line and six to eight electrical contacts placed on the centerline below the air line port. (The electrical contacts can be contained in a separate detachable unit which could be securely attached as a later modification to the air connector unit.)

2) The basic connector design shall be "spread-wing" which will include the capability of subsequent design modifications to increase gathering capability while remaining compatible with original designs.

3) Connector must have the capability of gathering (a) horizontally, with the distance between the connector centers a maximum of ±5", (b) vertically, with the distance between connector centers a maximum of ±5", and (c) when the horizontal angle between connector center lines is a maximum of 17 degrees.

4) Connector must not be damaged by coupler by-pass or miscouplings.

5) Connector should incorporate self-centering means to assure that the connector is on coupler center in an uncoupled position.

6) Connector should have a minimum number of parts, minimum amount of machining, be compact, sturdy and lightweight design in order to meet economic and serviceability/requirements.

7) Connector must permit necessary operations to be performed from either side of the car.

8) Connector shall incorporate a spring type self-loading capability having a thrust of at least 500 pounds force and a free longitudinal compression travel of at least 1-1/2 inches.

A.3 AIR LINE PROVISIONS

1) The airline port shall be butt faced and shall include a compressible outer seal providing for at least 1/4 inch compression.

2) Car angle cock location to be maintained within present location as specified by AAR. (Manual of Standards and Recommended Practices, Section E, Pages E-31-1965 to E-33-1965.) However, design provisions shall be made for location of a second angle cock as may be required for use in coupling with a nonequipped car.

3) Air brake hose attached to connector must be removable without uncoupling cars. It must be possible to make the Single Car Test without uncoupling cars.

4) Connector must operate without leakage under worn coupler condemning gage limits and with maximum vertical distance between coupler center lines of 8-1/4". (Displacement for vertical curve negotiation of 7-1/4" is required by AAR Specification Design, Fabrication and Construction of Freight Cars 2.6.)

5) Use of standard air hose gasket is desirable, but not required. (AAR Manual of Standards and Recommended Practices, Section A, Page M-602-63.) Use of present standard air brake hose length of 22" is preferred, but not required.

6) Coupled connectors, with hoses, must have air flow capacity equivalent to at least a 0.984" diameter square edged, 1/16" thick, orifice.

7) The brake pipe opening at the gasket face of the connector must be the lowest point in the brake pipe line to permit draining of water from the brake pipe and there must be a continuous drop from the angle cock to the connector coupling gasket to prevent water pockets.

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